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ABSTRACT

The role of visual imagery in the learning of letter-sound combinations was investigated using such mediating images as two scoops of ice cream for the letter "m." In a preliminary study, high-, medium-, and low-strength mediating images were determined for each letter-sound combination. The 216 kindergarten subjects in the main study were assigned to one of eight treatment conditions that differed in the mediators included in the 37-second films used for instruction. Each child was tested for recall of letter-sound correspondences before the experiment, immediately after the experiment, 24 hours later, and two weeks after the experiment. Results indicated significant learning gains favoring a three-mediator condition over all others tested; two-mediator conditions performed at virtually the same level of facilitation as one-mediator conditions. It seems that both mediator strength and number are important, provided that both are sufficiently high, but precise criteria under which both may be expected to facilitate learning are not yet at hand. (Author/AA)

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FINAL REPORT

The Effects of the Strength and Number of Visual Mediators in the Learning Process

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ABSTRACT

The role of visual imagery in the learning of letter-sound associations by kindergarten children was studied. Five specific questions were investigated: (1) does mediating imagery affect learning, (2) does mediator strength affect learning, (3) does the number of mediating images affect learning, (4) is there an interaction between mediator strength and number, and (5) is there an interaction between specific letter-sound associations and mediator strength and number.

Mediator strength was operationalized as follows. Associations to letter shapes and to letter sounds were collected from kindergarten-age children. Four mediating images, suggested by combining graphemic associations with those of corresponding phonemes were created for each letter-sound association. For example, a picture of twin scoops of ice cream was used to mediate the m - /m/ letter-sound association. In the presence of this mediator, the abstract shape of the grapheme, m, acquired a familiar meaning (two scoops of ice cream) as did the abstract phonemic response, /m/ ("good" or "tastes good").

The four pictures (each on a separate five-by-eight inch card) for each letter-sound association were presented to forty kindergarten children. Each child was individually asked to rank order the four pictures in a given set according to each picture's relative ability to imply the appropriate phoneme. An arbitrary point system (five, three, two, or zero points) was used to allocate a numerical value to each rank order position. For each letter-sound association, the pictures with the highest, middlemost, and lowest sum totals were designed as high, medium, and low strength mediators, respectively.

Each subject was assigned to one of eight treatment conditions: (1) no-mediator used, (2) low, (3) medium, or (4) high strength mediators used, combinations of (5) medium and low, (6) high and low, (7) high and medium, or (8) high, medium, and low strength mediators used.

The learning materials consisted of 256, thirty-seven second, 8mm sound films, which were identical in aural and visual format, differing only in the particular mediators used. A two-and-one-half minute task orientation film preceded the learning task.

Subjects were 216 kindergarten children from the Austin (Texas) Independent School District. Each of three schools furnished eight groups of nine children and each of these groups was randomly assigned to one of the eight treatment conditions. Each group was presented thirty-two letter-sound associations, eight a day for four consecutive days. Each child was individually pre-and post-tested. Three posttests were conducted: immediate recall, twenty-

four hour delayed recall, and two-week delayed recall.

The results of the data analyses revealed significant mean learning gain differences at the .05 confidence level or better in favor of the three-mediator treatment condition over all of the other seven mediator conditions in all three posttests. However, when mediator strength was taken into account, two mediators performed at virtually the same level of facilitation as one mediator. Only the strongest one- and two-mediator conditions, the high strength and the high-medium combinations, achieved statistical superiority over the no-mediator condition at the .05 level of statistical significance.

INTRODUCTION

The purpose of the research project was to study the role of visual imagery in the learning of letter-sound associations (LSA's) by kindergarten children. Both the external validity of relevant reading tasks, populations, and settings, and the internal validity characteristic of imagery investigations were combined within the framework of instructional film. It is thereby hoped that the forthcoming results will bring theoretical support closer to instructional media research and program design, application to imagery theory, and useful and effective knowledge, methodologies, and delivery systems to reading instruction.

Instructional media experiments all too often lack theoretical underpinnings necessary to support hypothesis testing and, consequently, effective program development (Saettler, 1968). Allen (1973) reiterated the long-standing call for such theoretical structures which he regarded as essential to unlock the vaunted instructional potentials of film and television.

Imagery theory lacks generalizability and applicability (Morris, 1972; Roberts, 1975). Despite all of the significant learning differences attributed to

imagery in theoretical studies with some investigators reporting learning differences of up to 600 percent (Bower and Clark, 1969), imagery theory has yet to realize practical application in educational institutions. At the heart of this shortcoming is the fact that imagery theory is supported by impressive arrays of psychological studies typically strong in internal validity but lacking external validity. This disciplined pursuit of significance must be matched by an equally zealous effort to promote generalizable tasks, settings, and populations.

Reading lacks effective systems of instruction. The problems of teaching children to read have been well publicized and well documented, resulting in widespread and diversified prescriptive efforts such as the Right to Read Program, The Electric Company, and seemingly ubiquitous remedial reading classes. Harris (1969), in a comprehensive state of the art review, summarized reading instruction's most critical needs: scientific research to develop a defensible theoretical base, reliable knowledge, and efficient instructional methodologies and materials. Towards these ends Horn (1970) requested that the powerful leverage of audio-visual media be applied to instructional reading programs.

The problem seemed clear. Instructional media (i.e., film and television) have enormous potential which

remains unrealized largely because of the lack of theoretical structures. Imagery has deep theoretical roots stemming from the verbal learning tradition and proliferating with hybrid vigor under the recent influences of cognitive psychology, but has yet to be applied in formal instructional situations. The reading problem occupies the schoolrooms, teachers, and children, but lacks effective methodology and materials. The present investigation uses the strengths of each area in an attempt to ameliorate the shortcomings of each.

This investigation was based upon the findings of recent visual imagery experiments: item concreteness, high stimulus imagery, interactive images,[1] and action pictures were all found to facilitate paired associate learning (Paivio, 1971). The present study used animated film techniques to measure the effects of visual mnemonic imagery in the paired-associate task of learning letter-sound associations, a basic reading skill. Procedures for combining each of thirty-two grapheme-phoneme pairs (see Appendix A) into mnemonic elaborations[2] were developed and

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[1] An interactive image is a mnemonic image which combines stimulus and response into a single context.

[2] An elaboration is a physical representation of a mental image (e.g., a picture).

the effects of varying elaborator strength and number were studied. Specifically, pictorial images perceptually organized the abstract stimuli (graphemes) into patterns relating to real-world objects and concepts which gave meaning to and subsequently implied the response items (phonemes). For example, twin scoops of ice cream may be used to mediate the m - /m/ letter-sound assocation (Figure 1). In the presence of the mediator the abstract shape of the grapheme, m, takes on a familiar meaning (two scoops of ice cream) as does the abstract phonemic response, /m/[3] ("good" or "tastes good"). The presentation of the letter shape m in recall trials suggests the mediator (two scoops of ice cream) which in turn facilitates recall of the phoneme /m/. Theoretically, then, it may be seen that the visual images facilitate all three component phases (stimulus discrimination, response discrimination, associating the stimulus with the response) of paired associate learning (PAL) as identified by Underwood and Schulz (1960).

Skinner (1960) demonstrated that behaviorism's principles, based on observable behavior could readily be used to produce efficient materials with which to manipulate "target" populations. This advantage of a simplistic

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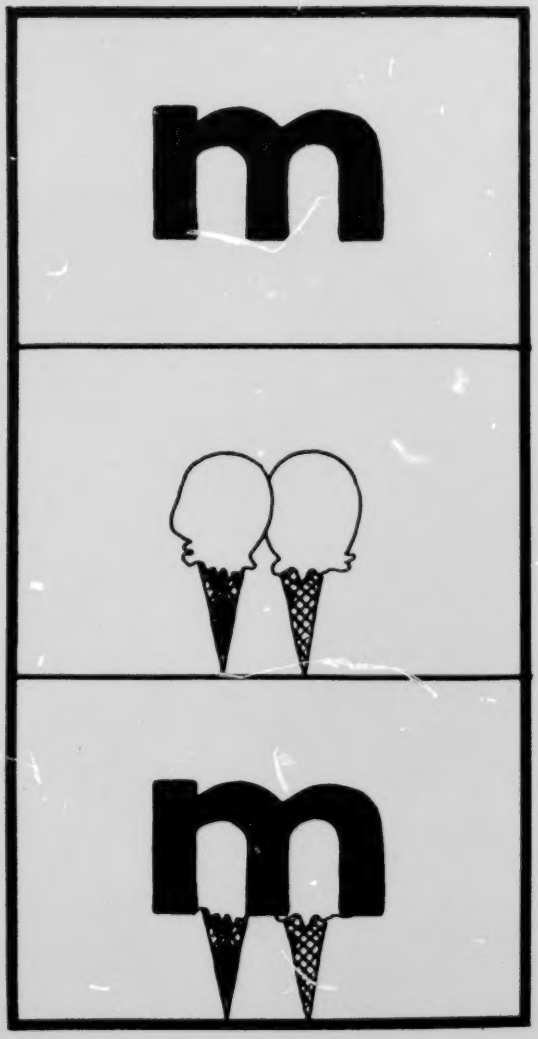
[3]The International Phonetic Alphabet as described by Broshnahan and Malmberg (1970) was the symbol system for phonemic designation which was used in the present study.



The shape of the grapheme, m,

implies the mediator (twin cones) which in turn

implies the meaning (delicious) associated with the response, /m/.

Figure 1. Ice Cream Cone Mediator proposed to facilitate the learning of the m-/m/ letter-sound association.

external behavior-oriented account of human learning ultimately proved to be a prime limitation of the behaviorist approach (Chomsky, 1959). One of the central premises underlying the current approaches to the study of imagery and cognitive psychology is that unseen complex activities involving the dynamic transformation of information take place internally. It is suggested here that the activity, complexity and invisibility involved in imagery and other cognitive processes may possibly be turned to considerable advantage.

Interesting possibilities arise if the manner in which the human mind abstracts, transforms, and juxtaposes information is coupled with the ability of moving image media (i.e., film and television) to dynamically transform information (Neisser, 1967), and if the human mental propensity for internalizing and imitating externally perceived phenomena (Piaget, 1951; Baran and Meyer, 1974) is coupled with film and television's hypothesized capacity to supplant human thought (Salomon, 1972). Moving image media may then be possibly provided with an opportunity to activate its seemingly considerable potential, and cognitive psychology may finally realize practical instructional application on a mass scale.

Although television and films are well suited to vary one dimension while holding others precisely fixed, few experiments in educational film or instructional tele-

vision have been so designed. It follows that few studies developed significance or general agreement in discerning either the efficiency or parameters of aural and visual stimuli. One constraint is that film is usually serially oriented and sequentially invariant. That is, film sequences usually follow one another in fixed order of presentation, resulting in an experimental bias which is very costly to control. By using modularly organized film cartridges the present study was able to randomize the presentation order of treatment variables.

At this point an explanation may be due those readers with competencies in linguistics or reading instruction. The author of this study is aware that certain phonemes may not be correctly pronounced as isolated units, and that the arbitrary voicing required in the learning task of this investigation may seem like a throwback to "grunt-and-groan" phonics. However, the films used in this study should not be thought of primarily as instructional programs but as materials which were specifically produced to serve the present scientific investigation. As such, as many uncontrollable contingencies and extraneous variables as possible were excluded. On the other hand, the instructional programs which may finally be constructed on the knowledge generated from this and companion studies would

integrate the learning of letter-sound associations with the acquisition of other reading skills such as phonic blending.

It may further be seen that if each letter-sound association were to be taught in combination with other letter-sound associations, the number of phonic units which children would have to learn would be greatly increased. For example, if knowledge of phonemes were to be taught using all possible two phoneme units comprised of just one vowel (V) and one consonant (C) from just the thirty-two letter-sound associations in Appendix A, 462 (11 x 21 VC and 21 x 11 CV) combinations would have to be learned instead of only the thirty-two original letter-sound associations. Thus, the instructional strategy for ultimately teaching each letter-sound association as an individual unit is additionally advocated out of concern for parsimony.

Finally, an actual reading program is not envisioned as a series of stimulus-response learning exercises; rather, the present method of learning letter-sound associations is seen as comprising only one small part of an overriding instructional framework designed primarily to promote reading comprehension. It is in this latter perspective that the instructional films of this present study may be properly seen not as an ultimate tool for facilitating the

acquisition of reading skills but as yet another step in a continuing evolutionary process.

STATEMENT OF THE PROBLEM AND HYPOTHESES

The present research was structured to determine the answers to questions involving the instructional use of film (and television). Although most educational technologists hold that all visual media have the potential to provide highly efficient instruction, the only evidence that is able to be musterei suggests that "film" and "television" are at least as effective as "traditional classroom instruction." In most of these studies, however, neither "film" - "television," nor "traditional classroom instruction" has been operationally defined in a manner which would permit generalization. Much as a result of this type of research, film and television are said to lack the theoretical structure necessary to unlock their instructional potential (Allen, 1973; Hitchens, 1975).

One of the important properties of the visual media is their imagery potential. The impact and ease of use of imagery and image associations are appealing aspects. However, little is really known about the specific effectiveness and the properties behind such effectiveness of this imagery component. Therefore, imagery, despite its instructional potential and its value as a source of theoretical support, has not yet become a variable of

interest in investigations of instructional moving image media.

The present film study investigated the efficiency of using imagery to teach letter-sound associations, and the properties of imagery in relation to the learning process. Concerning the task of teaching the thirty-two letter-sound associations, the problem was: (1) does mediating imagery affect the learning process, (2) does mediator strength affect the learning process, (3) does the number of mediating images affect the learning process, (4) is there an interactive effect between the strength and number of mediating images used, and (5) is there an interactive effect between specific letter-sound associations and the strength and number of mediating images used.

Based on past research, it was hypothesized that: (1) the use of mediating imagery will facilitate learning, (2) there will be a significant positive relationship between the strength of a mediating image and learning efficiency (3) there will be a significant positive relationship between the number of mediating images and learning efficiency, (4) there will be a significant positive interaction between the strength and number of mediating images such that learning efficiency will increase as mediator strength and number increase, and (5) there will be no

interaction effect between specific letter-sound associations and the strength or number of mediating images used.

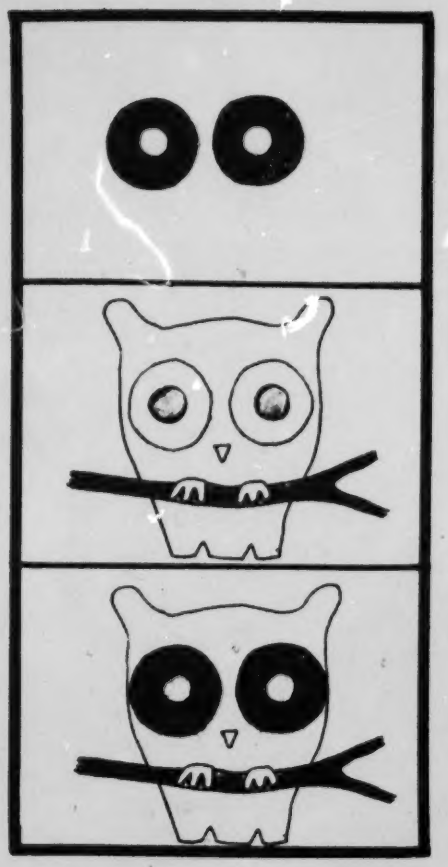
REVIEW OF PRIOR RESEARCH

Sufficient evidence exists to expect that integrative visual nmemonic elaboration will facilitate the paired associate learning of the letter-sound associations by young children. Paivio (1970), Rohwer (1970), and Reese (1970) concluded that imagery processes play a significant role in paired associate learning. Neisser (1972) suggested that visual mnemonic imagery is one of the most effective mental processes in learning performance. Paivio (1969) summarized a series of experiments which generated empirical evidence that nouns high in imagery are easier to learn than abstract words. Moreover, Paivio concluded that concreteness in the stimulus position had a greater facilitative effect than in the response position. In subsequent studies Rohwer, Lynch, Levin, and Suzuki (1967), Bower (1970, 1972), and Morris (1972) demonstrated interactive elaboration (especially in the context of an active relationship between stimulus and response) to be most facilitating on paired associate learning tasks. Integrating an abstract shape (i.e., grapheme) with its associated abstract sound (i.e., phoneme) into a single concrete image facilitates the learning of the association (Morris, 1972). For example, the grapheme oo is elaborated

as an owl's eyes (Figure 2), and the associated phoneme /u/ becomes concretely elaborated as the owl's hoot.

This study hypothesized that a central problem in teaching abstract concepts (i.e., letter-sound associations) to young children depends on the way the child perceives the stimulus (grapheme) and hence, on the manner of presentation. To the extent that a grapheme is perceived only as an abstract squiggle, there is a correspondingly small chance that the child will be able to organize the shape into a set of critical features and thereby facilitate its recognition and recall. The literature, while spotty in empirical evidence, suggests that animation and meaningfulness, i.e., Noble's m (Noble, 1952), relevantly applied, would be significant dimensions of presentation.

Neisser (1967) agrees with Schachtel (1959) that focusing attention on relevant aspects of objects is central to human learning. In Neisser's discussion the importance of movement, distinctness, and other qualities which enable a particular element to stand out, are important to pattern analysis. A perceptual pattern's chances of being perceived depends on the degree to which it is simply organized and differs clearly from its immediate environment. Arnheim (1969) contends that the beginning of concept formation lies in the perception of shape. Something is visually perceived only to the extent



letter

mnemonic elaborator

interactive image (letter superimposed upon elaborator).

oo is mediated as an owl's eyes and /u/ as the sound of an owl's hoot.

Figure 2. An example of an interactive elaboration to mediate the oo-/u/ letter sound association.

that it fits some organized shape within the individual's cognitive repertoire. From these conclusions the use of animation, to attract the eye to movement and to communicate the relevant aspects of grapheme shapes both in contrast to and in context with supporting visual information, should have a positive effect on facilitating learning.

Both Neisser (1967) and Arnheim (1969) concluded that a well-ordered and meaningful frame of reference is important to recognition (perception) and recall (remembering). This would seem to suggest that learning facilitation would vary directly with a mediator's strength, defined here as a mediator's capability to elicit a relevant, concrete and experientially established frame of reference connecting stimulus and response.

Mediational studies (Paivio, 1971) distinguish mediators by modality (e.g., aural, visual), by type of mnemonic strategy or organizing scheme (e.g., meaning, identification and organization of parts, analogy to familiar shapes, sound similarity such as alliteration or rhyme), by dynamic image qualities (e.g., S-R interaction, vividness, spatial organization) or by origination (e.g., self-generated by the learner or provided by the experimenter). Research has yet to become sensitive to a more fine grained classification of mediator attributes. For

example, the literature generally agrees that mediating imagery originated by the learner himself is more effective than imagery supplied to him. However, the most common explanation offered as to why this might be so is that self-generated mediators are idiosyncratic and therefore more comprehensible (Bower, 1972). No search for the factors which might account for this superior comprehensibility attributed to idiosyncratic imagery seems to have been conducted in order that such facilitative qualities might be extended to provided imagery. Clearly, in the absence of such understanding, provided mediators which share the same modality, organizing strategy, dynamic quality, or origination are assumed to be equally facilitative.

Wood and Bolt (1968) demonstrated the differential effect of different mediators. Appropriate (e.g., table to mediate the paired associates, t-chair) and inappropriate (e.g., table to mediate t-doctor or town to mediate t-chair) mediators were compared in two separate investigations. Groups supplied appropriate mediators scored higher than controls (no mediation provided). Those provided inappropriate mediators consistently learned less than control groups. These findings suggest that differential effects of mediators are related to preestablished associations between stimulus and

mediator and also between mediator and response. It might be additionally inferred that the direction (positive or negative) and perhaps the amount of facilitation varies with the "appropriateness-nonappropriateness" dimension which has been further refined in the present study and operationalized as strong, medium, and weak mediators.

The position that increased numbers of mediators would increase learning is supported by verbal learning literature (Paivic, 1971). The meaningfulness, i.e., the number of associations which a given item elicits in a given time (Noble, 1952), of either the stimulus or response term contributes to the learning of paired associates (Hall, 1971). Similarly, several studies established that mediator meaningfulness facilitates learning (Horton, 1964; Boersma et al., 1966; Montague et al., 1966).

The different implications of item meaningfulness and mediator meaningfulness should be distinguished. A greater number of mediators increases item (stimulus and/or response) meaningfulness by providing an increased number of associations and this should increase learning. The greater the meaningfulness of a mediator the larger the number of associations it should elicit; learning facilitation presumably results from the mediators's familiarity to the learner. It should be noted that a mediator's familiarity (i.e., the degree to which the

mediator is known to the learning population) is one component of mediator strength as operationalized in the present study. Additional factors involved in determining mediator strength are the degree to which the grapheme may be recognized as representing the mediator and the extent to which the mediator infers the phoneme. Information from other areas of research provides additional perspectives related to the issue of mediator number.

The literature seems to suggest that mere addition of either redundant or irrelevant units to learning situations would be marginally facilitative at best (Smith and Smith, 1966; Dwyer, 1972; Schramm, 1972). Attneave (1954), Rappaport (1957) and Broadbent (1965) all found that additional relevant but superfluous (i.e., redundant beyond the point of diminishing returns) stimuli diminished learning after an early peak. Reese (1970) suggests that the increase of proactive and retroactive interference, such as would be offered by an increased number of mediating images for each associated pair, decreases learning. More images would increase the number of cues, but would also offer increasing interference.

interference, presence and type of facilitation, number of items to be learned, time of exposure to stimulus and response, nature of presentation paradigm (Hall, 1971). Because so many contributing factors are undoubtedly interacting in the present study, no prediction of retention will be attempted. It is believed, however, that all possible factors affecting learning and retention have been controlled except for the variables of interest to the investigation.

The present study was based on a productive history of research and development in instructional media design and reading instruction. On April 15, 1972, a half hour lesson, co-produced and designed by this co-author, was telecast via three commercial channels in El Paso, Texas. Mnemonic imagery techniques similar to those described in the present study were applied to the learning of whole words (Coleman and Ackerman, 1972).

The El Paso program used a variety of techniques to facilitate children's learning and attending in addition to imagery. Mnemonic songs, running gags whose punch lines delivered fun and instructional objectives simultaneously, stop motion and animated film techniques, slapstick gags, numerous student-activating review procedures, accompanying comic strips in El Paso newspapers, and words selected from several of Coleman's (1970) learnability

From the above evidence, the mediator attributes of strength[4] and number would each be seen as capable of positive or negative effects. In the present study it might be expected to follow that strong mediators would be more facilitative than weak mediators which in turn may be no better (and possibly worse) than rote (the no mediator condition). Increasing the number of mediators should increase learning but to a lesser extent as the mediators used become progressively weaker. Although there are no precedents for prediction, strong mediator capabilities are expected to compensate for the number of mediators. Gains due to increasing mediator number should diminish beyond a certain number and seek an asymtote, but it is doubtful whether this effect will appear with a maximum of only three mediators in any treatment condition. Finally, since mediation is seen to facilitate both learning and recall, the initial early gains due to the mediator effects of strength and number should become more clearly manifested with the passage of time over which retention of paired associate item decays progressively at varying rates depending upon a variety of factors, e.g., nature of stimulus, nature of response, presence and type of

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[4]Mediator strength is operationalized as an index of the comparative rating preference of a pictorial mnemonic (relative to competing visuals) as accorded by a targeted learning population.

tables[5] were some of the variables which may have contributed significantly to the learning gains. Because so many uncontrolled factors were present, no definitive knowledge concerning the value of any to learning facilitation was possible. Thus, the present study was designed to permit the separation of the effects which might be attributed to mnemonic elaboration techniques.

Practical educators have been using mnemonic devices to teach letter-sound associations for many years. The earliest set of materials found by the present author was "Phonic Talking Letters" copyrighted by Edith E. Stephens in 1941. These consisted of a deck of picture cards (one card for each letter-sound association) depicting characters and objects in the shape of the various graphemes and a related story, read by the teacher, to facilitate the association between each grapheme and its phonemic equivalent. A similar approach was discussed by Zedler (1955). During the 1975 Association for Educational Communications and Technology (AECT) convention, International Film Bureau, Inc., of Chicago exhibited a series of twenty-six animated color films to teach the names of each letter in the

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[5]Coleman and his colleagues constructed a systematic set of data base tables which attempted to calibrate the various language units used in reading, (e.g., LSA's, phonic blending components, words, phrases) along dimensions such as ease of learning, frequency of occurrence, idiomaticy, and readability.

alphabet. Each film consisted of a story employing alliteration appropriate to the sound of the letter being presented. However, the present author could find no scientific investigation of mnemonic devices to facilitate learning of letter-sound associations until Morris (1972).

Morris constructed a series of line drawings based upon a hierarchy of associations to graphemes and phonemes collected from university undergraduates. Each of these pictures representing one of three types of mediating imagery: (1) stimulus related (SRI), e.g., depicting the grapheme h as a chair, (2) response related (RRI), e.g., depicting the phoneme /z/ as the buzz of a bee, or (3) interactive (II) imagery, were used to teach twenty letter-sound associations to sixteen preschool children. Each child was individually presented each grapheme on a card, the phonemic equivalent aurally, and the mediating image also on a card. The measure was the number of errors to learning. Morris found that II was slightly but not significantly more facilitative than RRI. Both, however, were significantly better than SRI.

The fact that RRI was found to be better than SRI seems to contradict the findings (Paivio, 1963, 1965, 1968a, 1969) upon which Paivio constructed his conceptual peg hypothesis (i.e., concreteness in the stimulus position provides an effective base on which to associate a response item). It should be noted that the Morris study differed

in several respects from the Paivio studies. Morris provided mediators, response items were aurally presented rather than visually (e.g., printed words or pictures), and subjects (Ss) were not university undergraduates. For these reasons, any attempt to generalize across the different tasks, populations, procedures, and measures of the Paivio and Roberts studies must be approached with caution (Morris 1972; Roberts, 1975). As a case in point, in a series of related studies by Paivio (1968b), Bugelski et.al. (1968), and Bower (1972), it was shown that concreteness of the mnemonic mediator provided little facilitative advantages. That conclusion, in sharp contrast to the powerful effect of the concreteness of the stimulus item, demonstrates that established findings pertaining to stimulus and response items in paired associate learning may not generalize to mnemonic mediators. So it may be that Morris' finding of the significantly greater effect of response related mediators may indicate that mediator-attribute investigations which strive for high levels of external as well as internal validity may provide insights useful to both learning and instruction.

Roberts (1975) attempted to study the effect that varying numbers of mediators would have on the learning of letter-sound associations. Roberts based his mediating drawings upon the same hierarchy of associations as Morris used. Roberts' Ss, twelve children fifty-six to seventy-

four months of age, learned thirty-two letter-sound associations under a latin-square design in which each student learned each letter-sound under one of four treatments (i.e., zero, one, two, or three mediators). Roberts' measure was the percentage of correct sounds recalled. Learning by all Ss revealed that performance increased linearly and varied directly with the number of mediators.

The success and shortcomings of both the Morris and the Roberts studies were important to the present work. Both Morris and Roberts used mediator hierarchies based upon associations obtained from a population (college undergraduates) different from that (predominantly five year old children) of this experiment. This might have constituted a source of uncontrolled contaminating factors. Clearly it would have been better if associations had been derived from relevant S populations (young children) and introduced some mechanism for determining the mediating capability of the resultant mnemonic picture. A larger N and a broader based subject pool than was used in the two studies being discussed (twenty Ss by Morris and twelve by Roberts, both drawn from the same nursery school) would increase confidence in the validity and the generalizability of results. The measure in the Morris experiment was number of errors to learning. To prevent overlearning, a given letter-sound was retired from a S's learning trials after

his first correct response to the letter. This resultant differential in learning presentations would almost surely confound results of delayed recall, important in most real-world learning tasks. Roberts' measure of percentage of correct responses allowed equal presentation trials and afforded more validity to delayed recall results.

In addition to those already mentioned, several other contaminating factors may have contributed to Roberts' results. Because elaborating mediators were accompanied by a simple story, the progressive effect attributed to increased numbers of pictorial mediators could have been influenced by an accompanying narrative account which became progressively "enriched" as the number of mediators increased. In addition several stories received special treatments to overcome particular problems involved in learning certain LSAs such as those designated in confusion matrices constructed by Popp (1964) and Marsh and Sherman (1970). For example, in teaching certain LSAs, (e.g., th-/ð/), Roberts embellished the visual and verbal mnemonic mediation by additionally including instructions relating to the proper placement of articulators. Although verbal narration and confusion reduction may play a powerful role in facilitating the learning of letter-sound associations, their uncontrolled presence impaired Roberts' attempt to separate completely the effect of varying the

number of visual mediators. Additionally, all mediators in the Roberts study were implicitly assumed to be equally facilitative. Because the presence of differential strength mediators was neither recognized nor controlled, another contaminating variable was probably present.

In conclusion, a more comprehensive controlled study with improved internal and external validity seemed to be in order. Accordingly, the present study investigated thirty-two letter-sound associations; mnemonic elaborators were based on association hierarchies generated from relevant populations; methods for measuring and comparing the strength and number of elaborators were developed; care was taken to prevent contaminating influences (e.g., verbal explication was controlled); the study was conducted in relevant settings using a relatively large N, and the film medium (to control presentation variables between treatments) was employed.

In reviewing research findings Lumsdaine (1968) blamed the weak findings of media researchers on a poor understanding of learning theory. In the opinion of the present author, such researchers should also have a thorough knowledge of media theories and techniques. They should be able to sort out and control the relevant and the irrelevant (and thus inferfering) stimuli. The failures of media researchers to encompass both learning theory and media

disciplines seems to be one reason why so few instructional media research studies yield significant or productive findings. In order to provide specific insight into the nature of this problem, two examples will be discussed.

Baker and Popham (1965) developed two versions of a mediated (film strip) instructional program which taught instructional objectives. Information was presented aurally and visually (via printed words). One version was additionally embellished with cartoon figures. The authors determined that there were no significant differences between the two treatments and had to conclude visuals were not facilitating to instruction. Inspection of the materials by this author revealed that Popham's visuals contributed no information relevant to desired terminal behaviors. It must be concluded that the cartoons provided offsetting effects. On the one hand, they constituted attractive stimuli which helped maintain student attention upon the viewing screen; on the other, the pictures provided competing stimuli which produced learning interference. The critical notion here is that the cartoons were relevant to neither en route nor terminal behaviors.

Another example concerns Dwyer's (1972) study of film strips teaching information about the human heart. Dwyer found simple line drawings more efficient than more realistic representations. However, in two similar

treatments (one with no visual illustrations) he actually had to conclude that a verbal stimulus without picture was more efficient than verbal stimulus with picture. Similarly, use of color was found to produce no significance. Again, investigation of the criterion test reveals no requirement necessitating visual knowledge of the heart. Furthermore, the visual stimulus remained unchanged regardless which part of the heart (e.g., ventricles, auricles) was discussed. Color did not separate parts or point out relationships (relevant or irrelevant to instructional objectives). Again, no reasonable conclusion about the efficient use of visuals can be made, simply because visuals were not instructionally functional and thus constituted interfering stimuli.

The reason for citing these two studies is to point up the relative lack of sophistication in current media research, and to underscore the potential importance of the current study. Present materials were developed to serve as a basis for future experiments which will systematically manipulate one variable at a time. A partial list of visual variables would include various types of animation; appearing-disappearing; changing color, size, or shape; and shape tracing. Other dimensions to be examined would include the use of detail, color, motion, and stimulus timing. This in-depth step-by-step approach seems

to answer Lumsdaine's (1968) requisite; to systematically vary instructional stimuli one element at a time rather than to conduct an unconnected series of experiments which fail to pin down parameters.

Much human learning research is concerned with factors that impede learning. In contrast, imagery research studies learning facilitation. The imagery research specific to this study examines methods and materials which produce efficient learner performance.

METHOD AND PROCEDURE

SUBJECTS

The subjects were 216 children with ages ranging from sixty-four to seventy-three months. All were drawn from the kindergartens of the Casis, Linder, and Pillow elementary schools in the Austin Independent School District, Austin, Texas, such that each school contributed seventy-two children. The three schools had predominantly Caucasian populations ranging from lower middle to high SES. Only children with no mental or physical handicaps were selected. In addition 110 subjects were male and 106 female.

The subjects were selected such that each school provided nine students to each of the eight treatment conditions; therefore, a total of twenty-seven children were supplied to each treatment. Each school had four kindergarten classes to which, according to school officials, children had been randomly assigned at the beginning of the school year. Each student of a given class was randomly assigned to one of the two treatment groups randomly designated for his particular class. Even though more than nine children from each class group were exposed to a particular treatment condition, the data from only nine children were randomly selected to be analyzed.

TREAMENTS

Each subject was assigned to one of eight treatment conditions: (1) no-mediator used, (2) low, (3) medium, or (4) high strength mediators used, combinations of (5) medium and low, (6) high and low, (7) high and medium, or (8) high, medium, and low strength mediators used. Each subject in each treatment was administered a pretest, had training with thirty-two letter-sound associations, and was subsequently administered immediate, twenty-four hour delayed recall, and two-week delayed recall posttests.

LEARNING MATERIALS

Selection of visual materials was based on image associations that were collected during the school year prior to the experiment from three groups of preschool and kindergarten children with ages ranging from sixty to seventy-eight months. The first two groups, each consisting of sixty children, were drawn at random from the Austin Community, Child's Play, and Country Air nursery schools and from the kindergarten of Pillow Elementary School in Austin, Texas.

The children assigned to Group One were individually requested to provide associations to each of the thirty-two graphemes (see Appendix A) being studied in this investigation. After a brief introduction in which the nature of the task was explained each child was given

practice making associations to several abstract figures such as a triangle, rectangle, asterisk, and the letters x and c. After the child was provided an opportunity to respond to each figure (no responses were judged as correct or incorrect; all associations were encouraged), he was verbally supplied several possible solutions. Following an opportunity to visualize each suggestion, an appropriate illustration was pictorially presented. For example, the rectangle was visually organized as a door, a window, a toy block, or a box. After each example provided, the child was encouraged to provide more associations to the shape. Once the experimenter (E) was satisfied that the nature of the task was understood, each of the thirty-two graphemes, printed in block letters on plain five-by-eight cards, was presented one-at-a-time in random order.

Each child in Group Two, after instructions and appropriate practice in supplying associations to phonemic sounds not used in the present study, was presented the sound assigned to each of the thirty-two letters (randomly selected) and asked to describe the thing or event which the sound evoked. In each of the two tasks just described, each child was allowed twenty seconds in which to provide associations. Each task continued until all thirty-two of its items were exhausted or until the child was allowed to retire because of fatigue or disinterest. Thus, the lists

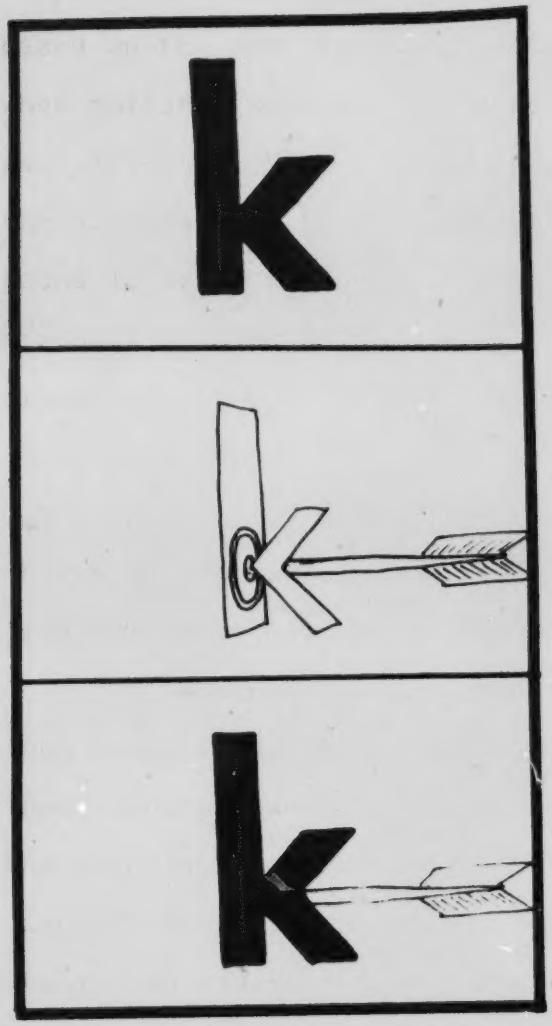
of associations to graphemes and phonemes as provided by preschool and kindergarten children (Appendix B) do not represent a one hundred percent response to all items by all children participating in a particular task. However, since in each of the two association tasks items were presented in random order, all items were presented with approximately equal frequency.

The task of providing associations to abstract shapes and sounds was rather difficult for this age group and most children were unable to produce an association to every item. Idiosyncratic assocations (i.e., one-of-a-kind responses made to a particular item) were not included in Appendix B. The E has taken the liberty of organizing related objects and concepts into a single category. Thus for the phoneme, /æ/, "lamb" responses were tallied with the "sheep" responses. Whenever possible, scattered specific associations were generalized into a single category. For example, the association to the graheme k, designated in Appendix B as "a pointed object in contact with a straight object," was generalized from specific idosyncratic associations such as "a house and a sharp finger" and "a sideways tepee touching the sky."

Four pictures were constructed for each grapheme-phoneme pair by a team of six artists. Each picture was rendered as simply as possible on a five-by-eight card and was registered to the appropriate standard sized grapheme

to promote size and positioning conformity. Images were based on the associations collected in Appendix B except when children were unable to produce a sufficiency of associations. Furthermore, an attempt was made to overlap the associations to each letter and those of its associated sound in order to increase the contributions to image strength from both the stimulus and response sides. For example, the picture of an arrow striking a target (Figure 3) created to mediate the k - /k/ LSA was suggested by combining the Appendix B graphemic association, "a pointed object in contact with a straight object" with the generalized Appendix B phonemic association, impact.

Where necessary, additional mediators were drawn from suggestions by the artists, E, and his colleagues. These concepts were sought because, as previously stated, the associations provided by the children were not sufficient to generate the number of mediators required by the study. In addition, E was curious to gain insights into the facilitation of adult-generated mediators relative to those which were provided by children. Also, although adult-generated mediators might not be as effective as children's, they would constitute a source of the weak mediators required by the study. Appendix C lists the four pictorial mediators which were produced to mediate each LSA. An example of the visual rendering may be seen



Associations to the grapheme shape generalized as a pointed object in contact with a straight object,

were paired with associations to the phoneme generalized as (the sound of an) impact.

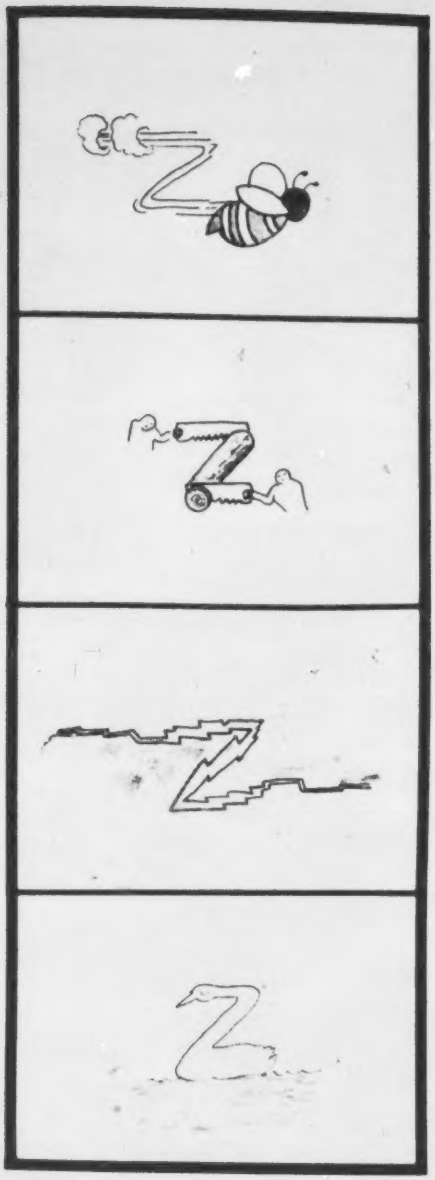
Overlapping of these associations to the grapheme and to the phoneme suggested the visual mediator, arrow striking target, to facilitate the learning of the k-/k/ letter sound association.

Figure 3. Arrow striking target: A mediator for the k-/k/ letter-sound association. Illustration of a method used to generate visual mediators.

in Figure 4 which presents the four pictorial mediators produced for the z /z/ letter-sound association.

Although based upon relevant and frequently occurring associations, the resultant artists' drawings might not be recognizeable or understood and thus not useful to members of the learning population. Therefore, ratings of image strength also needed to take into account the effectiveness of the pictures as actually rendered. Accordingly, mnemonic strength was operationalized by the relative rating a picture received as a mediator of a particular letter-sound association. Group Three, comprised of forty kindergarten children from the Casis and Pillow Elementary Schools and not used in the subsequent learning study, were asked to rate the pictures for each grapheme-phoneme pair. The E addressed children individually and explained the nature of the task according to the following:

> Today we're going to play some games with pictures and letters. This is a letter. When you learn to read, you learn the sound that goes with each letter. Do you know what sound goes with this letter (show grapheme c)? This letter says /k/. Can you say /k/? (Wait for answer briefly). Okay, this letter says /k/!
>
> I am going to show you some pictures that look like this letter (place pictures before child). Do you see that each picture has a part that looks like this letter? (The letter is superimposed over each picture). Which picture is best for telling you that the sound of this letter is /k/? (Waits breifly for reply, asks why chosen picture is preferred. When appropriate reply is not



Mediator A
Strong mediator
Bee flying zigzag

Mediator B
Medium mediator
Sawing wood

Mediator C
Weak mediator
Lightning bolt

Mediator D
not used
Snoozing swan

Figure 4. The four pictorial mediators produced for the z-/z/ letter-sound association.

> forthcoming, E explains). This letter looks like this cake, (superimpose letter) and the first sound of the word "cake" is /k/. This letter also looks like your mouth when you cough (superimposes letter) and the sound a cough makes is /k/. This letter also looks like the moon (superimpose letter), and about the only /k/ that the moon helps me think of is the /k/ for the cow that jumped over the moon. Now, which picture is best for telling you that this letter says /k/? Which picture is worst; which picture is no good for telling you that this letter says /k/? (Appropriately acknowledge and praise child's responses).

When the E was satisfied that the child understood what was expected, the E proceeded with the data collecting procedure. A small carton held thirty-two packets, one for each grapheme used in the study. Each packet contained five cards, four with pictorial mediators and one with the associated grapheme painted on a clear plastic sheet. The E randomly selected a packet and started the data collecting procedure as follows:

> Here's another letter! What does this letter say? (While awaiting response, E places pictures randomly before child). This letter says / / (E indicates sound of letter). All of these pictures look like this letter (superimpose letter over each picture), but which picture best tells you that this letter says / /? (E waits for a child to make his selection or repeats question). That's good. Now, be careful; which picture is no good for telling you that this letter says/ /? (E acknowledges choice, then arranges the two pictures selected in a vertical row, best at the top, worst at the bottom). Okay, this is the picture which is best for telling you that this letter says / /. And this picture is no good for telling you that / / is the sound of this letter.

The child was then asked to select the better of the two remaining pictures. The picture selected was arranged in second position just under the selection designated by the child as best. The remaining picture was placed in third position just under the second best selection and just above the selection designated as worst mediator. Finally the child was offered an opportunity to approve or adjust his choices. The ranking of the mediators was tallied, and the cards were replaced in the packet which was then set aside. The procedure was repeated until all thirty-two packets had been exhausted or until the E determined the child was unwilling to continue.

Each first place vote was accorded five points, three points for second place, two for third, and zero for last. The pictures receiving the highest and lowest totals were designated as the strong and weak mediators respectively. The picture which received the point total most nearly midway between the highest and lowest total was chosen to be the medium strength mediator. The high (H), medium (M), and low (L) strength mediators for each letter-sound association were used in the production of the experimental learning films. Appendix C, which lists the four mnemonic pictures which were produced to mediate each of the LSA's, also indicates the ranking tallies and total points scored by each and the designation of the H, M, and L strength mediators.

The experimental films were 256, thirty-seven second (888 frames each), super 8mm color sound films, one film for each of the eight treatment conditions accorded each of thirty-two letter-sound associations. Figure 5 contains a sample exposure sheet for zero, one-, two-, and three-mediator conditions.

It may be seen from the sample exposure sheet, Figure 5, that each of the eight films for each LSA contained a four second (ninety-six frame) introduction section and a three second (seventy-two frame) coda. In between the introduction and the coda sections were six five-second cycles (120 frames each).

Each of the six cycles within each film was in turn evenly subdivided into four thirty-frame (one-and-one-quarter second) shots (illustrated in Figure 6) as follows:

(1) shot one contained a tinted (green) transparent sheet with the grapheme cut out so that the grapheme highlighted the letter-shaped section of the mediator (for the control condition no mediator was used; therefore a blank white card was substituted in its place) which was visible from under the green transparency;

(2) in shot two the transparent tinted sheet with the grapheme cut out was removed leaving the mediator (or the blank card for the control condition) all alone;

(3) shot three was a repetition of shot one;

Cycle no.	Shot no.	No Mediators			One Mediator			Two Mediators			Three Mediators		
		frame no.	stimuli visual	aural	frame no.	stimuli visual	aural	frame no.	stimuli visual	aural	frame no.	stimuli visual	aural
(intro)		0-96	L		0-96	L		0-96	L		0-96	L	
1	1	126	0		126	0+1		126	0+1		126	0+1	
	2	156	-	/L/	156	1	/L/	156	1	/L/	156	1	/L/
	3	186	0		186	0+1		186	0+1		186	0+1	
	4	216	1	/L/	216	L	/L/	216	L	/L/	216	L	/L/
2	1	246	0		246	0+1		246	0+2		246	0+2	
	2	276	-	/L/	276	1	/L/	276	2	/L/	276	2	/L/
	3	306	0		306	0+1		306	0+2		306	0+2	
	4	336	L	/L/	336	L	/L/	336	L	/L/	336	L	/L/
3	1	366	0		366	0+1		366	0+1		366	0+3	
	2	396	-	/L/	396	1	/L/	396	1	/L/	396	3	/L/
	3	426	0		426	0+1		426	0+1		426	0+3	
	4	456	L	/L/	456	L	/L/	456	L	/L/	456	L	/L/
4	1	486	0		486	0+1		486	0+2		486	0+1	
	2	516	-	/L/	516	1	/L/	516	2	/L/	516	1	/L/
	3	546	0		546	0+1		546	0+2		546	0+1	
	4	576	L	/L/	576	L	/L/	576	L	/L/	576	L	/L/
5	1	606	0		606	0+1		606	0+1		606	0+2	
	2	636	-	/L/	636	1	/L/	636	1	/L/	636	2	/L/
	3	666	0		666	0+1		666	0+1		666	0+2	
	4	696	L	/L/	696	L	/L/	696	L	/L/	696	L	/L/
6	1	726	0		726	0+1		726	0+2		726	0+3	
	2	756	-	/L/	756	1	/L/	756	2	/L/	756	3	/L/
	3	786	0		786	0+1		786	0+2		786	0+3	
	4	816	L	/L/	816	L	/L/	816	L	/L/	816	L	/L/
(coda)		888	L		888	L		888	L		888	L	

LEGEND:
- L: grapheme (black on white)
- 0: transparent green tinted plastic overlay with appropriate grapheme shape cut out.
- 1: first mediator selected.
- 2: second mediator selected
- 3: third mediator selected.
- /L/: sound of appropriate phoneme.
- -: blank frame.
- ID: "This letter says /L/."

Figure 5. Sample exposure sheet for the no-, one-, two-, and three-mediator treatment conditions.

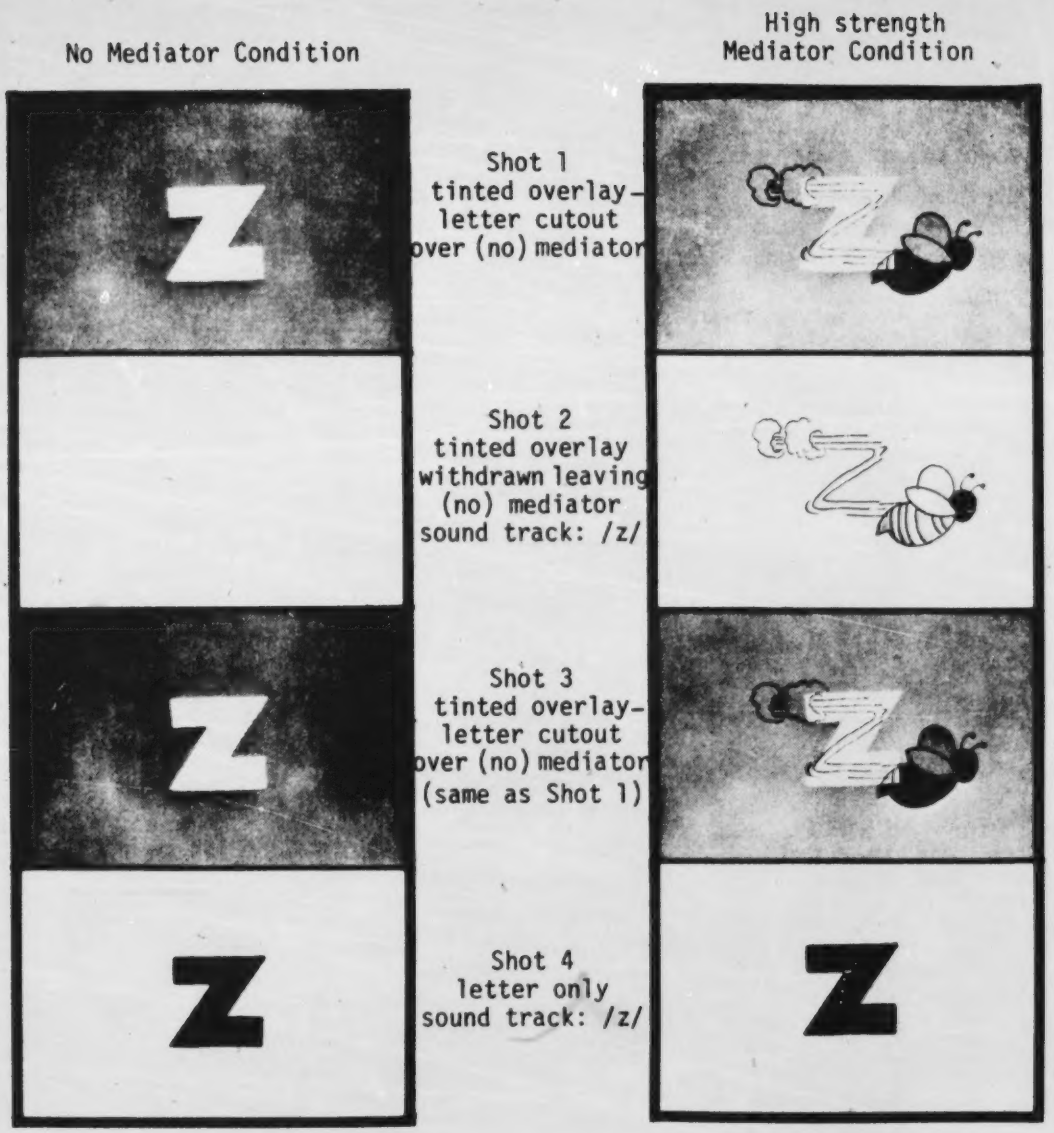


Figure 6. Illustration of the four shots which comprise one of the six five-second cycles of an experimental film as depicted by the control (no mediator) and the high strength mediator conditions of the z-/z/ letter-sound association.

(4) shot four contained the grapheme in black (registered to the position of the cut out letter in the previous shot) over a clear white card. Shots one, two, three, and four are illustrated in Figure 6 for both a mediator condition and the control (no mediator) condition for the z - /z/ grapheme-phoneme pair.

For a one-mediator condition (high, medium, or low mediator treatments) film, the same mediator was used in all six cycles. For a two-mediator condition (high-medium, high-low, or medium-low mediator treatments) film, mediators were alternated (with the first mediator randomly selected). For the nigh-medium-low mediator (HML) treatment, the appropriate three mediators were used such that each of the three mediators was randomly placed in each of the first three cycles and the order was repeated in the last three cycles.

The sound track (in addition to the introduction and coda sections already indicated) consisted of the pronunciation of the phoneme during shots two and four of each cycle. The same sound track was dubbed onto all eight of the films representing the eight treatment conditions of each letter-sound association.

Additional constraints were imposed on production procedures in order to control non-experimental variables. Exposure time, lighting, mediator and grapheme size and

positioning were held constant within and between all films. No out-of-order or incorrectly composed frames were permitted. A maximum error in frame count of two (one-twelfth of a second) was allowed in any one place on a given film with a maximum overall error of only four frames (one-sixth of a second) in count allowed in any one film.

A two-and-one-half minute animated super 8mm color-sound orientation film was also produced and introduced the chidren to the nature of the instructional films and the learning task as follows:

> These are letters. Letters have sounds. When you learn the sounds that these letters make, you will be able to read. You are going to see some pictures which will help you remember these letters and the sounds that these letters make.
>
> For example, this letter (x) says /ks/). This letter looks like a scissors, and when you use scissors, they make a sound like /ks/.
>
> And this letter says /ks/. So when you see this letter, remember it looks like a scissors and it will be easy to learn that this letter says /ks/.
>
> This letter also looks like a broken window; when a window breaks, it goes /ks/. If you remember that this letter looks like a broken window, it will be easy to learn that this letter says /ks/.
>
> Now here is another letter (c). This letter says /k/. this letter looks like your mouth when you cough, /k/. The first sound of the word cough is /k/ for cough; and the sound you make when you cough is /k/.
>
> This letter also looks like this cake. /k/ for cake. If you remember what this letter looks like, it will be easy for you to remember that this letter says /k/.
>
> Some of the letters will be shown with pictures to help you remember what the letters look like and to

help you remember the sound that goes with each letter.

Sometimes you may be shown a letter without any picture.

Sometimes you may be shown a letter with a picture that will help you remember the sound of the letter.

Sometimes you may be shown a letter with two or three pictures to help you remember the sound of the letter.

These instructions were given to all subjects in order to avoid introducing a source of differential performance among experimental groups.

Two Kodak super-8mm Supermatic 60-sound cartridge projectors were used to present the orientation film and the experimental films to the subjects. Super 8 film offered distinct cost advantages in raw stock, processing and equipment. For the classroom sized groups of this study, viewing quality was satisfactory. Furthermore, the cartridge system permitted randomizing of presentation orders, a factor not usually controlled in television and film studies because of the production, logistical, and presentation penalties in time and money.

PROCEDURE

Presentation and testing were carried out in three consecutive weeks, one week being required in each of the three schools used in the study. In addition a delayed recall test took place in each school seven to ten days after initial testing. The thirty-two letter-sounds

to be learned were randomly divided into four blocks of eight letter-sounds each. All letters of each of the four blocks were presented in random order, one block per day, on each of four consecutive days. Logistical considerations of each school (e.g., lunch schedules, teacher break times, rest periods) determined the time when each class could participate. All classes were tested in the morning except for two which convened only in the afternoon.

The experimental team (ET) consisted of six members of the Learning and Media Research Project of the University of Texas selected for their maturity and experience. Furthermore, all members had been instructed in the special presentation and testing procedures used in this study. A single test performance sheet was prepared beforehand for each child in order to record all his scores on all tests. Sheets were organized by school name, teacher name, child's name, and by a code name (e.g., bears, foxes) assigned to the particular treatment condition to which each child had been assigned. The code name was used for logistical purposes only in order to facilitate the process of assembling the children into their assigned treatment condition groups.

The same procedure was carried out in each class in all three schools as enumerated in Appendix D, the instructions to the ET regarding the schedule of procedures.

On the first day of testing in a school the ET would enter the classroom at the appointed time and would be introduced. The children were simply told that they were going to see some films that would help them learn the sounds of the letters of the alphabet. All the children of the class were then grouped according to their treatment condition assignments. Each member of both groups was then individually tested to determine knowledge of the eight letters to be presented that day. Each child was presented a randomly ordered grapheme printed on a five-by-eight plain white card and asked, "What sound goes with this letter?" Results were recorded (a sample test record sheet appears in Appendix E) and testing continued until all eight associations were pretested at which time another child was randomly selected. Pretesting continued until all children of both groups had been examined. The two groups were then moved to separate locations where each group was to be presented the films corresponding to the treatment condition to which it had been assigned.

On the initial day of testing in each school, the presentation of the experimental films to each group was preceded by the presentation of a two-and-one-half minute animated orientation film (the same film for all treatments) which prepared children for the learning task. Next, the eight learning films assigned to that particular

treatment condition for that day were presented in random order. The children were then returned to their classroom where the posttest for immediate recall (of the letters just presented) was administered in the same manner as the pretest as previously described.

The procedure followed on succeeding days in each school was similar to the first day with but a few exceptions, e.g., the introductory film was omitted and a twenty-four hour delayed recall test (conducted in the same manner as the pretest as described above) of the letter-sounds taught the previous day immediately preceded the administration of the pretest of the new associations to be taught that day.

On the last day of the week (the day after the last block of letters had been presented to all of the treatment conditions), the ET returned to the school and conducted the final twenty-four hour delayed recall test covering the last eight associations learned on the previous day. Twelve to seventeen days after the first block of films had been presented, the ET again returned to the school and conducted a single long-term delayed posttest covering all thirty-two LSA's.[6] In order to facilitate reporting

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[6]The variable time delay in administering the long term delayed posttest was necessitated because of conflicting scheduling commitments in two of the schools. The

the long-term delayed posttest will hereinafter be referred to as the two-week delayed posttest. The testing procedure was the same as before except that knowledge of all thirty-two letter-sound associations was measured. These presentation and testing procedures were identical in all three schools in which the study was conducted.

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long-term delayed posttest was conducted seventeen days after the first day of film presentations at Linder School, twelve days after the initial day at Pillow, and fifteen days following the first day of exposure at Casis.

STATISTICAL ANALYSES AND RESULTS

The dependent measure used in this study was a tally of one (1) for failure to provide a correct response, a tally of two (2) for a correct response. Thus, the mean scores for all treatment conditions may range from one to two inclusive. The data from the 216 subjects taken from three schools, on the thirty-two letter-sound associations across eight treatment conditions with pretest comparisons were analyzed with a separate 2 x 2 x 2 x 3 x 9 x 32 x 2 (H x M x L x Sch x S x A x P) factional repeated measures analysis of variance design for each of the three posttests (immediate, twenty-four hour delayed recall, two week delayed recall).

Factors H, M, and L indicate the high, medium and low strength visual mediators, respectively, each with two levels, mediator used and not used. Factor Sch was the particular school involved with three levels (School 1: Linder, School 2: Pillow, and School 3: Casis). Factor S was the students with each of the nine levels being one of the students nested within one of the schools and one of the treatments but across letter-sound associations and posttests (i.e. nine students per treatment per school). Factor A indicates the letter-sound associations with each

of the thirty-two levels being one of the letter-sound associations. All the subjects were used under all thirty-two levels of factor A (letter-sound associations). Factor P was the pre- and posttest comparison scores with two levels, a one (1) indicating pretest scores and a two (2) indicating posttest scores. Factor P, taking prior knowledge into account reflects overall learning gain. Thus, the other main effects and the interactions which do not include factor P do not reflect learning gains, do not permit the separation of experimental gain from prior knowledge, and, therefore, have limited meaning for the purposes of this study.

The analysis of variance was performed with the use of the BIOMED ANOVA-8 computer program. The methods suggested by Glass and Stanley (1970) were used to carry out the planned comparisons and the post hoc tests.

The rationale for using the repeated measures approach is that it permitted the assessment of learning effects within each child with respect to all thirty-two of the learning tasks, which comprise almost three quarters of the common grapheme-phoneme pairs (letter-sound associations) in the English language (Brosnahan and Malmberg, 1970). In this way, possible biases due to interactions of particular children with particular LSA's may be avoided. The present design permits a separation (and thus analysis) of effects due to the strength of particular mediators, from effects

due to an interaction of visual mediators, and from effects due to interactions of combinations of mediators with particular letter-sound associations (i.e., the effects of the various mediator strengths and/or numbers may be compared within or across letter-sound associations).

RESULTS

The analysis of variance summary tables for posttest one (immediate posttest), posttest two (twenty-four hour delayed recall posttest), and posttest three (two week delayed recall posttest) are contained in Table I. The significant main effects of the immediate posttest which appear in Table I are Sch ($F = 6.79$, $p < .002$), which detects school differences, A ($F = 69.80$, $p < .022$), which reflects any differences in the knowledge of particular letters, and P ($F = 364.36$, $p < .000$), which reflects the overall learning gain.

Interactions which do not contain factor P, do not take prior knowledge into account and cannot detect the presence of experimental gain. There were seven significant interaction effects of posttest one which do not contain factor P: HSch ($F = 5.59$, $p < .005$), MA ($F = 1.81$, $p < .004$), SchA ($F = 2.87$, $p < .000$), HLA ($F = 2.24$, $p < .001$), MLA ($F = 1.65$, $p < .013$), HMLA ($F = 1.92$, $p < .002$), and HLSchA ($F = 1.32$, $p < .050$). These may also be seen in Table I.

TABLE I

ANALYSIS OF VARIANCE SUMMARY TABLES FOR POSTTEST ONE (IMMEDIATE RECALL TEST), POSTTEST TWO (TWENTY-FOUR HOUR DELAYED RECALL TEST), AND POSTTEST THREE (TWO-WEEK DELAYED RECALL TEST)

Source▼	Posttest One		Posttest Two		Posttest Three	
	F-ratio	p(F)	F-ratio	p(F)	F-ratio	p(F)
H	.33	.565	.50	.479	.62	.432
M	.10	.758	.05	.830	.01	.941
L	.53	.470	.43	.514	.84	.360
Sch	6.79	.001†	6.79	.001†	7.67	.001†
A	69.80	.022*	75.68	.023*	85.15	.010*
P	364.36	.000†	346.53	.000†	201.09	.000†
HM	.18	.675	.12	.732	.05	.832
HL	.30	.584	.42	.520	.73	.395
ML	.61	.436	.85	.359	1.30	.256
HSch	5.59	.004†	4.92	.008*	5.28	.006*
MSch	.02	.978	.05	.957	.17	.844
LSch	.17	.845	.19	.824	.23	.794
HA	1.17	.233	1.29	.132	1.33	.104
MA	1.81	.004†	1.38	.077	1.44	.054
LA	.78	.806	1.11	.305	1.09	.331
SchA	2.87	.000†	3.25	.000†	2.23	.000†
HP	13.71	.000†	17.01	.000†	19.02	.000†
MP	2.58	.110	3.60	.059	5.69	.018*
LP	1.50	.223	.98	.324	3.43	.066
SchP	2.71	.069	2.40	.093	1.07	.346
AP	5.80	.000†	4.29	.000†	3.41	.000†
HML	3.06	.082	3.26	.072	3.93	.049*
HMSch	1.66	.193	2.00	.138	1.66	.193
HLSch	.73	.481	.52	.596	.94	.391
MLSch	1.96	.144	1.85	.161	1.90	.153
HMA	1.02	.437	.96	.530	.87	.678
HLA	2.24	.000†	2.68	.000†	2.54	.000†
MLA	1.65	.013*	1.22	.183	1.48	.042*
HSchA	1.30	.056	1.24	.095	1.23	.108
MSchA	.92	.663	.79	.884	.88	.746
LSchA	1.11	.267	1.13	.230	1.05	.373
HMP	3.00	.085	3.84	.051	5.84	.017*
HLP	1.35	.247	.64	.425	.02	.900
MLP	.51	.475	1.46	.229	3.66	.057
HSchP	1.41	.247	1.49	.227	1.13	.326
MSchP	.34	.712	.26	.775	.33	.723
LSchP	.48	.620	1.75	.177	1.19	.308
HAP	1.27	.144	1.19	.223	1.13	.287
MAP	1.41	.067	1.53	.030*	1.77	.005†
LAP	1.25	.159	1.29	.133	1.08	.353
SchAP	1.77	.000†	2.28	.000†	1.35	.000*
HMLSch	.36	.699	.73	.481	.61	.547
HMLA	1.92	.002†	1.73	.007*	1.56	.026*
HMSchA	1.01	.462	.87	.762	1.06	.352
HLSchA	1.32	.050*	1.49	.008*	1.58	.003†
MLSchA	1.22	.119	1.55	.004†	1.48	.009*
HMLP	7.91	.005†	6.38	.012*	4.03	.046*
HMSchP	.22	.803	.07	.931	.11	.900
HLSchP	.97	.379	.19	.831	2.24	.109
MLschP	.66	.519	1.04	.356	.66	.519
HMAP	1.33	.106	1.72	.008*	1.07	.356
HLAP	1.06	.384	1.01	.459	1.02	.431
MLAP	2.12	.000†	1.63	.015*	1.89	.002†
HSchAP	.86	.777	1.05	.371	.81	.864
MSchAP	1.41	.020*	1.27	.076	1.21	.125
LSchAP	1.01	.464	.86	.767	.84	.817
S(HMLSch) Δ						
HMLSchA	.93	.636	.93	.634	1.07	.335
HMLSchP	.69	.501	.02	.984	.31	.734
HMLAP	1.60	.019*	1.38	.079	1.10	.321
HMSchAP	1.13	.225	1.23	.110	1.22	.120
HLSchAP	1.20	.141	1.08	.317	1.20	.137
MLSchAP	1.04	.400	1.33	.043*	1.08	.307
SA(HMLSch) Δ						
SP(HMLSch) Δ						
HMLSchAP	1.07	.337	1.10	.284	1.16	.180
SAP(HMLSch) Δ						

LEGEND: Δ: Error term is not defined.
*: Results are significant at the $p < .05$ level or better.
†: Results are significant at the $p < .005$ level or better.
▼: See pages 51 and 52 for key to source factors.

The significant main effects of posttest two, which appear in Table I are Sch ($F = 6.79$, $p < .002$), A ($F = 75.68$, $p < .023$), and P ($F = 346.53$, $p < .000$). There were six significant interaction effects of posttest two (listed in Table I) which do not contain factor P: Sch ($F = 4.92$, $p < .009$), SchA ($F = 3.25$, $p < .000$), HLA ($F = 2.68$, $p < .000$), HMLA ($F = 1.73$, $p < .007$), HLSchA ($F = 1.49$, $p < .008$), and MLSchA ($F = 1.55$, $p < .004$).

The significant main effects of posttest three, which appear in Table I, are Sch ($F = 6.79$, $p < .002$), A ($F = 69.80$, $p < .022$), and P ($F = 364.36$, $p < .000$). There were seven significant non-factor P interactions which appear in Table I: HSch ($F = 5.59$, $p < .005$), MA ($F = 1.81$, $p < .004$), SchA ($F = 2.87$, $p < .000$), HLA ($F = 2.24$, $p < .001$), MLA ($F = 1.65$, $p < .013$), HMLA ($F = 1.92$, $p < .002$), and HLSchA ($F = 1.32$, $p < .050$).

The important interactions (also contained in Table I) which contain both factor Sch and factor P are: 1) SchP ($F = 2.71$, $p < .070$), SchAP ($F = 1.77$, $p < .001$), and MSchAP ($F = 1.41$, $p < .020$) in posttest one; 2) SchP ($F = 2.40$, $p < .094$), SchAP ($F = 2.28$, $p < .000$), and MLSchAP ($F = 1.33$, $p < .043$) in posttest two; and 3) SchP ($F = 1.07$, $p < .347$) and SchAP ($F = 1.85$, $p < .001$) in posttest three. The SchP interactions detect the presence of any differences in learning which may be attributed to school differences. The SchAP interactions would be sensitive to school dif-

ferences in learning particular LSA's. The MSchAP interaction would be sensitive to school differences in learning particular LSA's under the facilitating effect of a medium strength mediator.

The HP, MP, and LP interactions compare the gains achieved by treatment conditions which use mediators of a particular strength with those conditions which do not use that particular strength mediator. Thus, the HP interaction compares the mean gains of those treatment conditions which use the strong (high strength) mediator (H) with the mean gains of those conditions which do not use the strong mediator (NH). Similarly, MP pits the mean gains of those conditions which use M, the medium strength mediator against those conditions which do not use the M mediator (NM), and LP pits L, the weak (low strength) mediator, versus NL. Thus, these interactions should detect the superiority of those conditions which contain a certain strength mediator over those which do not. Table II has been constructed from the data of the HP, MP, and LP interactions and includes the F ratios, probabilities, means, mean gain scores, and mean gain score differences of all three posttests along with the pretest mean scores for H versus NH, M versus NM and L versus NL.

The posttest one results for these interactions are HP : $F = 13.71$, $p < .000$; MP : $F = 2.58$, $p < .110$; and LP : $F = 1.50$, $p < .223$. The posttest two results are

TABLE II

F-RATIOS, ASSOCIATED PROBABILITIES, MEANS, MEAN GAINS, AND MEAN GAIN DIFFERENCES FOR POSTTESTS ONE, TWO, AND THREE, AND PRETEST MEANS FOR THE HP, MP, AND LP INTERACTIONS

		PRETEST	POSTTEST ONE			POSTTEST TWO			POSTTEST THREE		
		mean scores	mean scores	mean gain scores	mean gain score differences	mean scores	mean gain scores	mean gain score differences	mean scores	mean gain scores	mean gain score differences
HP	H*	1.254	1.461	.207	.067	1.463	.209	.075	1.425	.171	.080
	NH†	1.269	1.409	.140		1.403	.134		1.360	.091	
				F=13.71 p<.000			F=17.01 p<.000			F=19.02 p<.000	
MP	M*	1.249	1.438	.189	.029	1.438	.189	.034	1.402	.153	.044
	NM†	1.273	1.433	.160		1.428	.155		1.382	.109	
				F=2.58 p<.110			F=3.60 p<.059			F=5.69 p<.018	
LP	L*	1.267	1.452	.185	.023	1.448	.181	.019	1.415	.148	.035
	NL†	1.256	1.418	.162		1.418	.162		1.369	.113	
				F=1.50 p<.223			F=.98 p<.324			F=3.43 p<.066	

*treatment conditions which used designated mediator
†treatment conditions which did not use designated mediator

HP : $F = 17.01$; $p < .000$; MP : $F = 3.60$, $p < .059$; and LP: $F = .976$, $p < 3.24$. The posttest three results are HP : $F = 19.02$, $p < .000$; MP : $F = 5.69$, $p < .019$; and LP : $F = 3.43$, $p < .066$. It should be noted that HP is highly significant in all three posttests ($p < .000$) and that MP is the only one of the interactions to yield significance at the .05 level or better ($p < .019$) and then only in posttest three. The Figure 7a graph compares the mean gain scores of the HP, MP, and LP interactions for all three posttests. Note the consistently higher performance of the H gains over both the M and L gains; note also that the gains of L are lowest, M, middlemost; and those of H are highest. Figure 7b presents graphs of the significant posttest one, two, and three HP interactions. It should be noted that the steepness of the H slope increases over time relative to the slopes of NH.

The F ratios, probabilities, means and mean gain scores of the two-mediator gain interaction effects (HMP, HLP, and MLP) for all three posttests are contained in Table III. These two-mediator gain interactions compare the performance of two particular strength mediators versus either mediator alone versus neither mediator used. For example, HMP compares the gains of the HM conditions, the H-non-M conditions, the M-non-H conditions and the non-H-non M conditions.

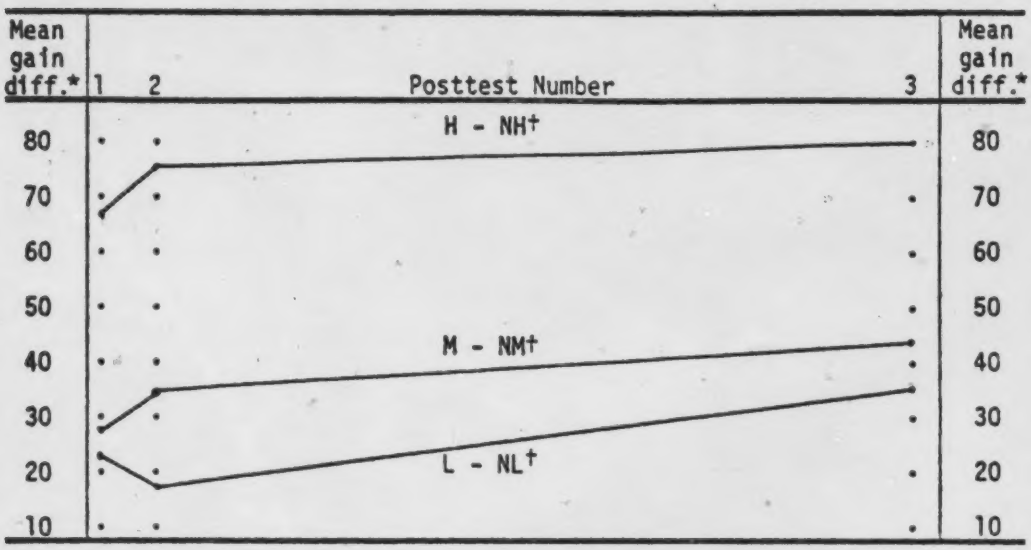


Figure 7a. Mean gain differences of the HP, MP, and LP interactions for the three posttests.

* In thousandths
† mediator used minus mediator not used

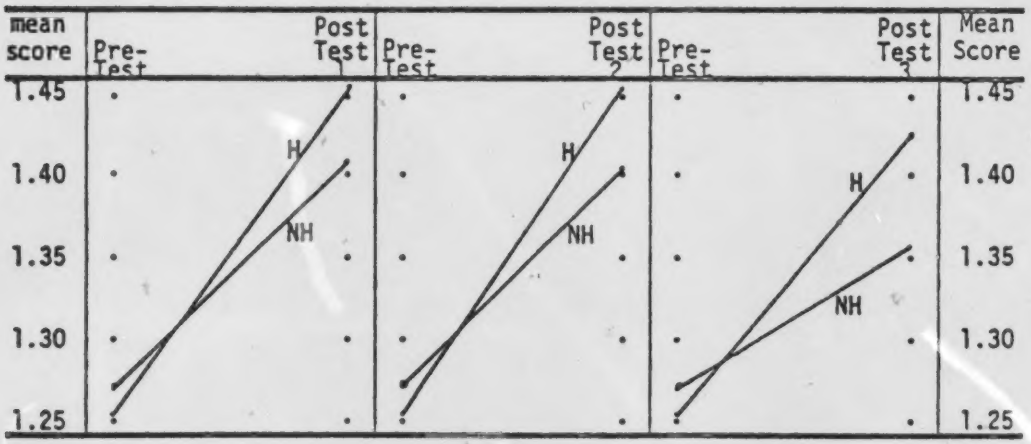


Figure 7b. HP interaction effects for the three posttests: high mediator used vs. not used (H vs. NH).

TABLE III

F-RATIOS, ASSOCIATED PROBABILITIES, MEANS, MEAN GAINS OF THE TREATMENT CONDITIONS (Tc) ASSOCIATED WITH THE TWO-MEDIATOR GAIN INTERACTIONS (HMP, HLP, AND MLP) FOR POSTTESTS ONE, TWO, AND THREE, APPROPRIATE PRETEST MEANS AND PLANNED COMPARISONS BETWEEN HM$^{\Delta}$ AND H$^{\nabla}$ OF THE HMP INTERACTION FOR ALL THREE POSTTESTS

INTERACTION	TC	PRETEST	POSTTEST I (IMMEDIATE)		POSTTEST 2 (24-HOUR DELAY)		POSTTEST 3 (2-WEEK DELAY)	
		MEANS	MEANS	MEAN GAINS	MEANS	MEAN GAINS	MEANS	MEAN GAINS
HMP	HM*		F = 3.00 p < .085		F = 3.84 p < .051		F = 5.84 p < .071	
	11	1.267	1.408	.141	1.401	.134	1.358	.091
	12	1.271	1.410	.139	1.405	.134	1.362	.091
	21†	1.280	1.457	.177	1.454	.174	1.407	.127
	22†	1.227	1.465	.238	1.472	.245	1.442	.275
HLP	HL*		F = 1.35 p < .247		F = .640 p < .425		F = .016 p < .900	
	11	1.249	1.389	.140	1.381	.132	1.324	.075
	12	1.289	1.429	.140	1.424	.135	1.395	.106
	21	1.262	1.447	.185	1.455	.193	1.414	.152
	22	1.245	1.475	.230	1.472	.227	1.435	.190
MLP	ML*		F = .512 p < .475		F = 1.46 p < .229		F = 3.66 p < .057	
	11	1.277	1.431	.154	1.433	.156	1.386	.109
	12	1.270	1.434	.164	1.423	.153	1.379	.109
	21	1.234	1.405	.171	1.403	.169	1.352	.118
	22	1.264	1.470	.206	1.473	.209	1.451	.187

Δ Treatment conditions which use both high and medium strength mediators.

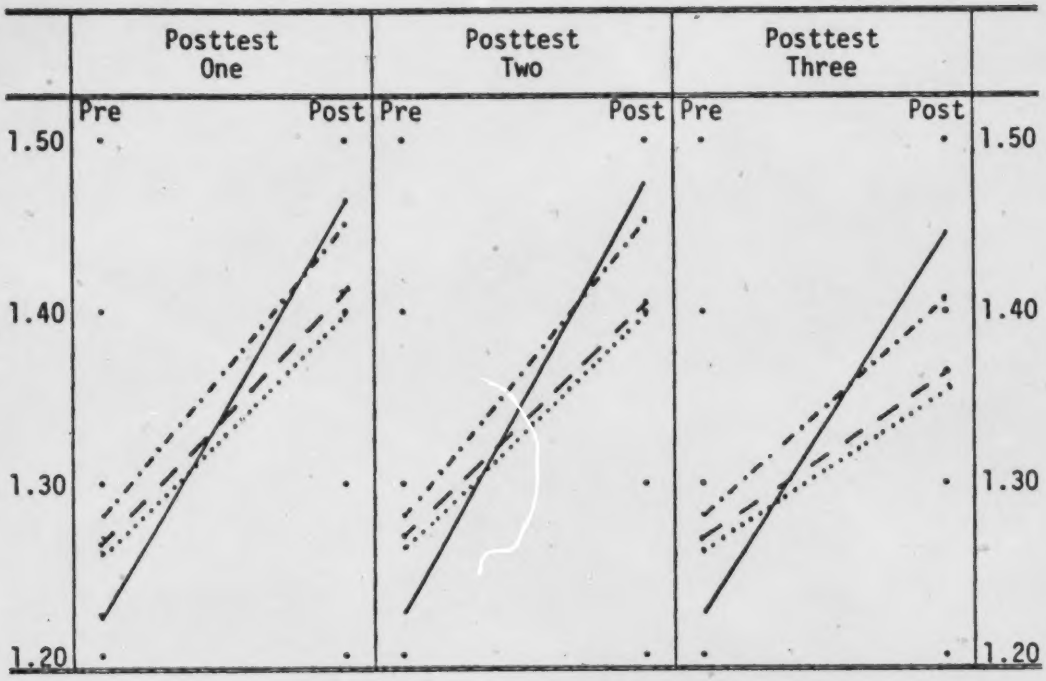
∇ Treatment conditions which use high but not medium strength mediators.

* A two (2) indicates designated mediator used, a one (1) indicates designated mediator not used.

† Planned comparisons between 22 and 21 mean gains of the HMP interaction:

Mean Gain difference	Posttest 1	Posttest 2	Posttest 3
= 22 - 21	= .238-.177 = .061 F = 1.676 df = 3/864 p > .05	= .245-.174 = .071 F = 1.919 df = 3/864 p > .05	= .215-.127 = .088 F = 2.378 df = 3/864 p > .05

It should be noted that only in posttest three does HMP achieve statistical significance ($F = 5.84$, $p < .017$) although performing close to significance in both posttest one ($F = 3.00$, $p < .085$) and posttest two ($F = 3.84$, $p < .051$). HLP did not approach significance ($F = 1.35$, $p < .247$; $F = .640$, $p < .425$; $F = .016$, $p < .900$) in any of the respective posttests. MLP very nearly achieved significance in posttest three ($F = 3.66$, $p < .057$), although it was well off the mark in posttest one ($F = .512$, $p < .475$) and in posttest two ($F = 1.46$, $p < .229$). Figure 8 presents in graphic form the pre- and posttest means and mean gains of the HMP interactions of all three posttests relative to the H, the M, and the non-H-non-M conditions. Note the staying power of the slope of HM over time (from posttest one to posttest three). The other lines decrease in slope relative to the persistent HM line, until in posttest three the H line has faltered sufficiently to finally permit the HMP interaction effect to achieve significance. Planned comparison T-tests between HM and H were conducted for each of the posttests as revealed in Table III for all three posttests. As expected from the probability levels associated with the HMP interaction effects in the analysis of variance conducted upon each of the three posttests, only in posttest three does HM finally achieve superiority ($F = 2.378$, $df = 3/864$, $p < .05$) over H.



*The four mediator treatment conditions of HMP are:

1) neither high nor medium strength mediators used (····)
2) medium but not high strenth mediators used (----)
3) high but not medium strength mediators used (-·-·)
4) both high and medium strength mediators used (——)

Figure 8. Graph of the pre- and posttest means which illustrate the mean gains registered by the four mediator treatment conditions* of the HMP interactions in all three posttests.

The HMLP interaction effects (included in Table I) achieved statistical significance in posttest one ($F = 7.91$, $p < .005$), posttest two ($F = 6.38$, $p < .012$), and posttest three ($F = 4.03$, $p < .046$). The HMLP interaction permits separation of each of the eight treatment conditions (no mediators, L, M, H, ML, HL, HM, and HML) so that experimental gains of any combination of the three mediators may be directly compared. A direct treatment-by-treatment comparison was thereby conducted by using Tukey's multiple comparisons post hoc test for each of the three posttests. The mean gain scores associated with each of the treatment conditions, the mean gain differences between each pair of treatment conditions, and the Ψ (psi) or critical value necessary to achieve significance at each comparison level for posttests one, two and three are presented in Tables IV, V, and VI respectively. $\hat{\Psi}$ (psi hat) is the actual difference between mean gain scores against which Ψ is compared to determine whether significance has been achieved. Table IV with a Ψ value of .054 at the $p < .05$ level of statistical significance, reveals HML's superiority to each one of the other seven treatment conditions, i.e., no mediator ($\hat{\Psi} = .169$), L ($\hat{\Psi} = .130$), M ($\hat{\Psi} = .133$), H ($\hat{\Psi} = .104$), ML ($\hat{\Psi} = .170$), HL ($\hat{\Psi} = .124$), and HM ($\hat{\Psi} = .107$). Also HM is superior at the .05 level to the no mediator condition ($\hat{\Psi} = .062$) and to ML ($\hat{\Psi} = .063$). Finally H is superior

TABLE IV

TUKEY POST-HOC TEST FOR SIGNIFICANCE BETWEEN EACH OF THE EIGHT MEDIATOR-TREATMENT CONDITIONS (TC) OF THE HMLP INTERACTION† FOR THE IMMEDIATE POSTTEST (POSTTEST ONE)

Mean gain scores, mean gain score differences, and critical mean gain score difference values necessary to achieve significance

	TC		111	112	121	211	122	212	221	222
		Mean Gains	.122	.161	.158	.187	.121	.167	.184	.291
$\hat{\Psi}$ = Mean Gain Difference	111	.122	$\hat{\Psi}$							
Ψ = .054 critical value	112	.161	.039	$\hat{\Psi}$						
MSerr = .286	121	.158	.036	-.003	$\hat{\Psi}$					
n = 1728	211	.187	.065*	.026	.029	$\hat{\Psi}$				
df = 7/13,816	122	.121	-.001	-.040	-.037	-.066*	$\hat{\Psi}$			
	212	.167	.045	.006	.009	-.020	.046	$\hat{\Psi}$		
	221	.184	.062*	.023	.026	-.003	.063*	.017	$\hat{\Psi}$	
	222	.291	.169*	.130*	.133*	.104*	.170*	.124*	.107*	

* Significant difference indicated at the $p < .05$ level.

† The eight mediator-treatment conditions for the HMLP interactions involve the eight possible combinations of the high (H), medium (M), and low (L) mediators. Each mediator strength has a designated position in HML; a one (1) in a particular mediator position of HML indicates mediator strength not used, a two (2) indicates mediator strength used. Thus the eight possible treatment conditions of HML are 111,112, 121, 211, 122, 212, 221, and 222.

TABLE V

TUKEY POST-HOC TEST FOR SIGNIFICANCE BETWEEN EACH OF THE EIGHT MEDIATOR-TREATMENT CONDITIONS (TC) OF THE HMLP INTERACTION† FOR THE 24-HOUR DELAYED POSTTEST (POSTTEST TWO)

Mean gain scores, mean gain score differences, and critical mean gain score difference values necessary to achieve significance

	TC		111	112	121	211	122	212	221	222
		Mean Gains	.121	.148	.144	.192	.123	.157	.195	.296
$\hat{\Psi}$ = Mean Gain Difference	111	.121	$\hat{\Psi}$							
Ψ = .056 critical value	112	.148	.027	$\hat{\Psi}$						
MSerr = .294	121	.144	.023	-.004	$\hat{\Psi}$					
n = 1728	211	.192	.071*	.044	.048	$\hat{\Psi}$				
df = 7/13,816	122	.123	.002	-.025	-.021	-.069*	$\hat{\Psi}$			
	212	.157	.036	.009	.013	-.035	.034	$\hat{\Psi}$		
	221	.195	.074*	.074	.051	.003	.072*	.038	$\hat{\Psi}$	
	222	.296	.175*	.148*	.152*	.104*	.173*	.139*	.101*	

* Significant difference indicated at the $p < .05$ level.

† The eight mediator-treatment conditions for the HMLP interactions involve the eight possible combinations of the high (H), medium (M), and low (L) mediators. Each mediator strength has a designated position in HML; a one (1) in a particular mediator position of HML indicates mediator strength not used, a two (2) indicates mediator strength used. Thus the eight possible treatment conditions of HML are 111, 112, 121, 211, 122, 212, 221, and 222.

TABLE VI

TUKEY POST-HOC TEST FOR SIGNIFICANCE BETWEEN EACH OF THE EIGHT MEDIATOR-TREATMENT CONDITIONS (TC) OF THE HMLP INTERACTION† FOR THE TWO-WEEK DELAYED POSTTEST (POSTTTEST THREE)

Mean gain scores, mean gain score differences, and critical mean gain score difference values necessary to achieve significance

	TC		111	112	121	211	122	212	221	222
		Mean Gains	.074	.108	.076	.145	.106	.109	.161	.269
$\hat{\Psi}$ = Mean Gain Difference	111	.074	$\hat{\Psi}$							
Ψ = .056 critical value	112	.108	.034	$\hat{\Psi}$						
MSerr = .294	121	.076	.002	-.032	$\hat{\Psi}$					
n = 1728	211	.145	.071*	.037	.069*	$\hat{\Psi}$				
df = 7/13,816	122	.106	.032	-.002	.030	-.039	$\hat{\Psi}$			
	212	.109	.035	.001	.033	-.036	.003	$\hat{\Psi}$		
	221	.161	.087*	.053	.085*	.016	.055	.052	$\hat{\Psi}$	
	222	.269	.195*	.161*	.193	.124	.163*	.160*	.108*	

* Significant difference indicated at the $p < .05$ level.

† The eight mediator-treatment conditions for the HMLP interactions involve the eight possible combinations of the high (H), medium (M), and low (L) mediators. Each mediator strength has a designated position in HML; a one (1) in a particular mediator position of HML indicates mediator strength not used, a two (2) indicates mediator strength used. Thus the eight possible treatment conditions of HML are 111, 112, 121, 211, 122, 212, 221, and 222.

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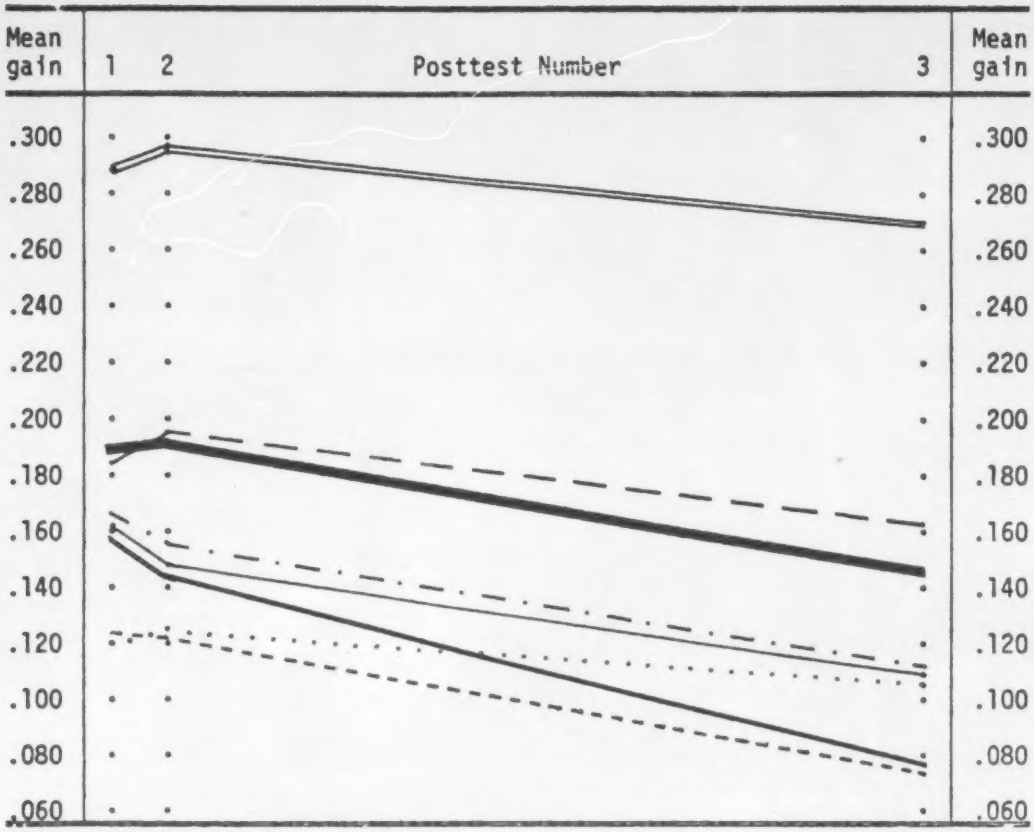
at the .05 level to the no mediator condition ($\hat{\Psi}$ = .065) and to ML ($\hat{\Psi}$ = .066).

For posttest two, Table V with a Ψ value of .056 shows HML to be statistically superior at the .05 level to all other treatment conditions, i.e., the no-mediator condition ($\hat{\Psi}$ = .175), L ($\hat{\Psi}$ = .148), M ($\hat{\Psi}$ = .152), H ($\hat{\Psi}$ = .104), ML ($\hat{\Psi}$ = .173), HL ($\hat{\Psi}$ = .139), and HM ($\hat{\Psi}$ = .101). Also HM is superior at the .05 level to both the no-mediator condition ($\hat{\Psi}$ = .074) and to ML ($\hat{\Psi}$ = .072). In addition, H achieves superiority at the .05 level over the no-mediator condition ($\hat{\Psi}$ = .071) and over ML ($\hat{\Psi}$ = .069).

In Table VI for posttest three, the Ψ level is .056. HML is shown to be statistically superior at the .05 level to all other treatment conditions, i.e., the no-mediator condition ($\hat{\Psi}$ = .195), L ($\hat{\Psi}$ = .161), M ($\hat{\Psi}$ = .193), H ($\hat{\Psi}$ = .124), ML ($\hat{\Psi}$ = .163), HL ($\hat{\Psi}$ = .160), and HM ($\hat{\Psi}$ = .108). Also HM is superior at the .05 level to both the no-mediator condition ($\hat{\Psi}$ = .087) and to M ($\hat{\Psi}$ = .085). In addition, HM very narrowly misses attaining statistical significance at the .05 level over L ($\hat{\Psi}$= .053, Ψ = .056), ML ($\hat{\Psi}$ = .055, Ψ = .056), and HL ($\hat{\Psi}$ = .052, Ψ = .056). Finally H is shown to be superior at the .05 probability level of statistical significance over no-mediator ($\hat{\Psi}$ = .071) and over M ($\hat{\Psi}$ = .069).

Figure 9 graphically compares the eight treatment conditions by plotting their mean gain scores for all three posttests. In Figure 9 the superiority of HML over the other treatment conditions is easily seen. Although the declining slopes of the learning gains lines for most of the treatment conditions seem to be very nearly parallel between posttest two and posttest three, the percentage of the retention which each line represents is quite different. Thus, the .027 units lost by HML represents an approximately ninety percent retention level and the .040 units lost by L indicates a retention level of about seventy-three percent. Table VII contains the percentage of learning gains retained by each of the eight treatment conditions from posttest one to posttest two, from posttest two to posttest three, and from posttest one to posttest three. The higher retention percentages of relatively stronger and larger numbers of mediators will be noted. Thus from posttest one to posttest three the H condition displays stronger retention (78%) than M (48%) or L (67%). The rate of retention of the three two-mediator conditions, from posttests one to three, averages 80% and thus seems to be better than the retention rate of the one-mediator conditions which average only 65% over the same time period.

Figures 10a, 10b and 10c plot the learning gain trend as a function of gradually increasing the strength



*The eight mediator treatment conditions are: no mediator(---), low (——), medium(————), high (▬▬), medium & low (····) high & low (— · — ·), high & medium (— —), and high, medium, & low (——) mediators.

Figure 9. Graphic comparison of the mean gains of the eight mediator treatment conditions* across the three posttests.

TABLE VII

RATES OF RETENTION OF MEAN GAINS BETWEEN THE THREE POSTTESTS FOR EACH OF THE EIGHT TREATMENT CONDITIONS (TC's) INDIVIDUALLY AND FOR ALL ONE-MEDIATOR TREATMENTS COMBINED AND FOR ALL TWO-MEDIATOR TREATMENTS COMBINED

TC†	MEAN GAIN* FOR POSTTEST			PCT OF RETENTION FROM POSTTEST		
	1	2	3	1 to 3	1 to 2	2 to 3
111	122	121	74	61	99	61
112	161	148	108	67	92	73
121	158	144	76	48	91	53
211	187	192	145	78	103	76
122	121	123	106	88	102	86
212	167	157	109	65	94	69
221	184	195	161	88	106	83
222	291	296	269	92	102	91
one mediator	506	484	329	65%	97	68
two mediator	472	475	376	80%	101	79

*In thousandths.

†The eight mediator-treatment conditions for the HMLP interactions involve the eight possible combinations of the high (H), medium (M), and low (L) mediators. Each mediator strength has a designated position in HML; a one (L) in a particular mediator position of HML indicates mediator strength not used, a two (2) indicates mediator strength used. Thus the eight possible treatment conditions of HML are 111, 112, 121, 211, 122, 212, 221, and 222.

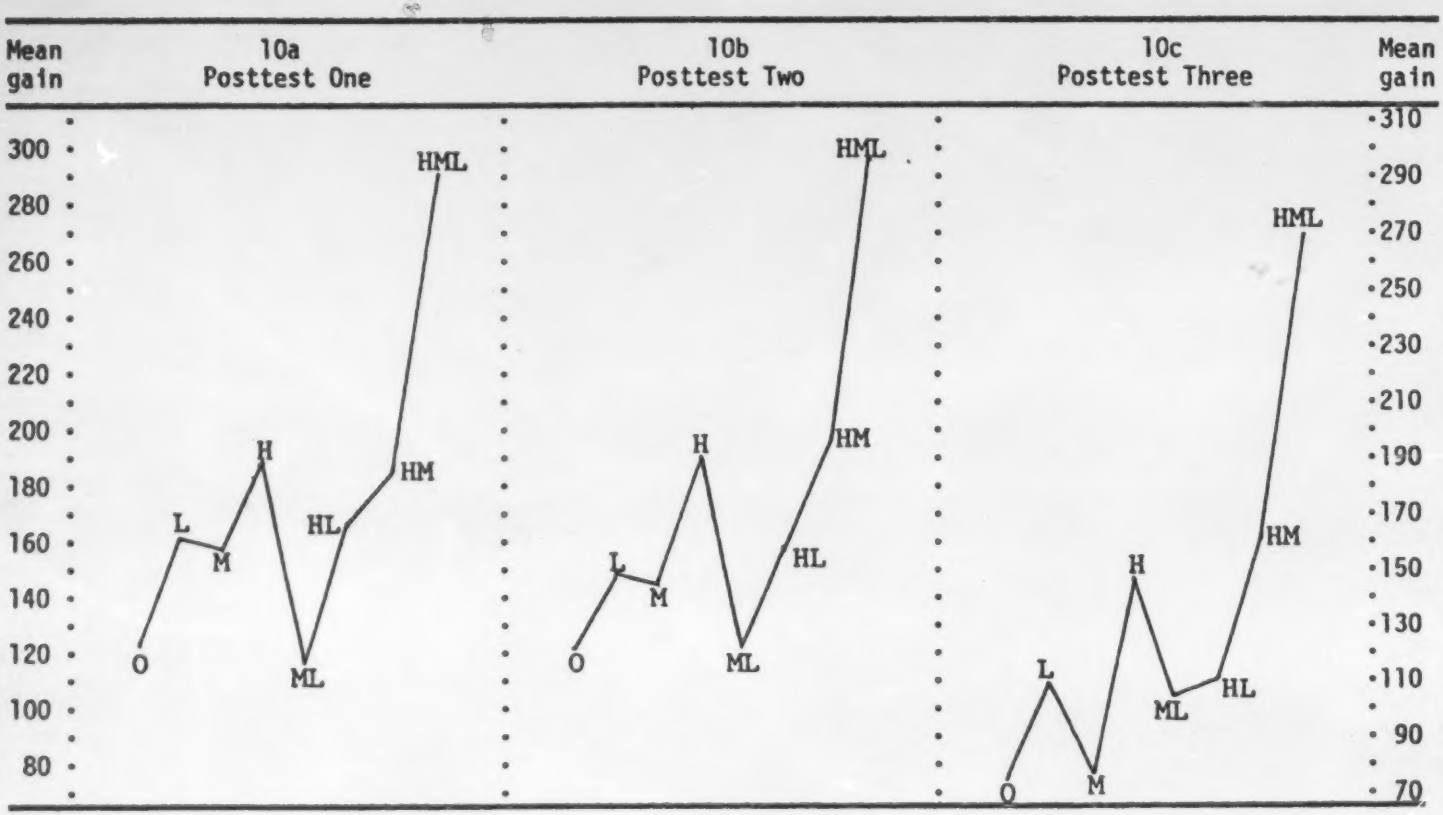


Figure 10. Learning gain (in thousandths) as a function of progressively increasing the strength and number of mediators used: from no mediators (O), to one mediator progressing from low (L) to medium (M) to high (H) strength, to two mediators progressing from medium and low (ML) to high and low (HL) to high and medium (HM) strength combinations, to all three mediator strengths used (HML) for posttests a) one; b) two; and c) three.

and the number of mediators (i.e., from no-mediator to L to M to H to ML to HL to HM to HML) for posttest one, posttest two, and posttest three, respectively. The trend to greater gains as a function of mediator strength within an equal number of mediators (i.e., from L to M to H and from ML to HL to HM) will be noted for all three posttests. The only break in this trend is the negative behavior of the M mediator in all three posttests. A large drop in learning gains may be seen in all three posttests as the graph proceeds from a lesser number of strong mediators to a greater number of weak mediators (i.e., as the graph proceeds from H to ML). The relatively low standing of the no-mediator gains and the high level of the HML mediator condition gains is evident in all three graphs.

Table VIII presents the analysis of variance F-ratios and probability levels associated with the interaction effects of the learning gain differences between particular LSA's, which might be attributed to the influence of particular strength mediators and combinations of particular mediator strengths for all three posttests. The significant posttest one effects are MLAP ($F = 2.115$, $p < .0003$) and HMLAP ($F = 1.600$, $p < .0187$). The significant posttest two effects are MAP ($F = 1.531$, $p < .0301$), HMAP ($F = 1.715$, $p < .0081$), and MLAP ($F = 1.627$, $p <$

TABLE VIII

TABLE OF THE POSTTEST ONE, POSTTEST TWO, AND POSTTEST THREE ANALYSES OF VARIANCE F-RATIOS AND PROBABILITIES OF THOSE INTERACTIONS WHICH REFLECT THE LEARNING GAIN EFFECTS (FACTOR P) UPON PARTICULAR LETTER-SOUND ASSOCIATIONS (FACTOR A) BY THE VARIOUS MEDIATORS AND COMBINATIONS OF MEDIATORS

INTERACTION	POSTTEST ONE		POSTTEST TWO		POSTTEST THREE	
	F-RATIO	p(F)	F-RATIO	p(F)	F-RATIO	p(F)
HAP	1.271	.1441	1.183	.2233	1.127	.2872
MAP	1.405	.0674	1.531	.0301*	1.774	.0052*
LAP	1.252	.1591	1.285	.1334	1.077	.3529
HMAP	1.327	.1062	1.715	.0081*	1.074	.3563
HLAP	1.055	.3843	1.005	.4593	1.023	.4309
MLAP	2.115	.003*	1.627	.0154*	1.885	.0021*
HMLAP	1.600	.0187*	1.379	.0786	1.101	.3205

* Results are significant at the $p < .05$ level or better.

.0154). The significant posttest three effects are MAP ($F = 1.774$, $p < .0052$) and MLAP ($F = 1.885$, $p < .0021$).

The significant probability value for the MAP interactions in the ANOVA indicates the presence of differences in learning particular LSA's due to differential facilitation provided by particular medium strength mediators. Planned comparisons were conducted in an attempt to identify some of the particular medium strength mediators which might be contributing to such an effect. Table IX presents data related to the MAP interaction effects: the pretest means, posttest three means, and mean gain scores for each of the thirty-two LSA's under both M (treatment conditions which use medium strength mediators) and NM (treatment conditions which do not use medium strength mediators) conditions, and M minus NM mean gain score differences between particular LSA's. It should be noted that seventeen (almost half) of the mean gain difference scores (M - NM) registered virtually no difference (i.e., within plus or minus .03) between M and NM mean gains. The other fifteen mean gain differences (all larger than .03) indicated a tendency toward superiority in the direction of M mediators.

In order to determine which particular medium strength mediators might be contributing differentially to the learning of particular LSA's, it was necessary to

TABLE IX

MAP INTERACTION EFFECTS: PRETEST MEANS, POSTTEST THREE MEANS, AND MEAN GAIN SCORES FOR EACH OF THE THIRTY-TWO LETTER-SOUND ASSOCIATIONS (LSA's) UNDER TREATMENT CONDITIONS WHICH USE MEDIUM STRENGTH MEDIATORS (M) AND WHICH DO NOT USE MEDIUM STRENGTH MEDIATORS (NM) AND MEAN GAINS SCORE DIFFERENCES BETWEEN THE M AND NM

LSA	NM			M			MEAN GAIN DIFFERENCE (M - NM)
	PRETEST SCORE	POSTTEST ONE	MEAN GAIN	PRETEST SCORE	POSTTEST ONE	MEAN GAIN	
a - /æ/	1.24	1.38	.14	1.28	1.46	.18	.04
ay - /e/	1.05	1.11	.06	1.05	1.13	.08	.02
b - /b/	1.31	1.46	.13	1.13	1.43	.30	.17
ch - /tʃ/	1.07	1.17	.10	1.11	1.19	.08	-.02
d - /d/	1.26	1.37	.11	1.22	1.35	.13	.02
e - /ɛ/	1.19	1.31	.12	1.29	1.38	.09	-.03
ee - /i/	1.36	1.44	.08	1.27	1.48	.21	.13
f - /f/	1.34	1.54	.20	1.36	1.48	.12	-.08
g - /g/	1.19	1.30	.11	1.20	1.33	.13	.02
h - /h/	1.19	1.28	.09	1.22	1.31	.09	0
I - /ɪ/	1.05	1.18	.13	1.12	1.23	.11	-.02
j - /dʒ/	1.46	1.68	.22	1.41	1.62	.21	-.01
k - /k/	1.56	1.75	.19	1.48	1.80	.32	.13
l - /l/	1.18	1.29	.11	1.17	1.28	.11	0
m - /m/	1.45	1.58	.13	1.38	1.49	.11	-.02
n - /n/	1.29	1.32	.03	1.22	1.35	.13	.10
o - /ɑ/	1.25	1.34	.09	1.21	1.44	.23	.14
oa - /o/	1.06	1.18	.12	1.13	1.22	.09	-.03
oo - /u/	1.16	1.29	.13	1.17	1.33	.16	.03
ow - /aʊ/	1.06	1.18	.12	1.06	1.23	.17	.05
oy - /ɔ/	1.07	1.12	.05	1.05	1.13	.08	.03
p - /p/	1.54	1.69	.15	1.56	1.68	.12	-.03
r - /r/	1.30	1.44	.14	1.29	1.46	.17	.03
s - /s/	1.78	1.86	.08	1.62	1.86	.24	.16
sh - /ʃ/	1.12	1.19	.07	1.07	1.24	.17	.10
t - /t/	1.55	1.70	.15	1.51	1.67	.16	.01
th - /ð/	1.08	1.12	.04	1.07	1.19	.12	.08
u - /ə/	1.19	1.25	.06	1.10	1.23	.13	.07
v - /v/	1.46	1.49	.03	1.35	1.55	.20	.17
w - /w/	1.30	1.37	.07	1.24	1.34	.10	.03
y - /j/	1.06	1.14	.08	1.12	1.27	.15	.07
z - /z/	1.60	1.73	.13	1.52	1.71	.19	.06

compare the M versus NM learning gain differences between LSA's. Table X contains planned comparisons of mean gain score differences between the b - /b/ and the m - /m/ LSA's ($\hat{\Psi}$ = .19), between ee - /i/ and ch - /tʃ/ ($\hat{\Psi}$ = .15) between s - /s/ and p - /p/ ($\hat{\Psi}$ = .19), between o - /ɑ/ and i - /I/, ($\hat{\Psi}$ = .17), between k - /k/ and e - /ɛ/ ($\hat{\Psi}$ = .15), between v - /v/ and l - /l/ ($\hat{\Psi}$ = .17), and between the sh - /ʃ/ and f - /f/ ($\hat{\Psi}$ = .18) LSA's. Significant differences in learning gains at the .05 level were registered for all these paris when their respective $\hat{\Psi}$ (actual difference) values were compared to Ψ = .12, the critical difference value for significance at the .05 level. From Table IX it may be seen that these differences may be attributed to the greater facilitation of M over NM in the b - /b/, ee - /i/, s - /s/, o - /ɑ/, k - /k/, v - /v/, and sh - /ʃ/ pairs and to the virtual zero differences in facilitation between the M and NM conditions in the m - /m/, ch - /tʃ/, p - /p/, i - /I/, e - /ɛ/, l - /l/, and f - /f/ pairs.

Table XI contains a listing of the learning gains which may be attributed to the four different mediator conditions, i.e., 1) neither medium nor low mediators used (NMNL); 2) low but not medium mediators used (LNM); 3) medium but not low mediators used (MNL); and 4) both low and medium mediators used (ML), involved in the post-test three MLAP interaction effects for all thirty-two LSA's. It may be seen from a comparison of the four gain

TABLE X

PLANNED COMPARISONS OF THE MAIN LEARNING GAIN DIFFERENCE BETWEEN THE M† AND THE NM$^{\Delta}$ TREATMENT CONDITIONS OF THE POSTTEST THREE MAP INTERACTIONS FOR PARTICULAR LETTER-SOUND ASSOCIATIONS (LSA's)

LSA's COMPARED	LEARNING GAIN DIFFERENCE	$\hat{\Psi}$	Ψ = .12
b - /b/ : m - /m/	.17 - (-.02)	.19*	MSerr = .0597
ee - /i/ : ch - /tʃ/	.13 - (-.02)	.15*	n = 108
s - /s/ : p - /p/	.16 - (-.03)	.19*	
o - /ɑ/ : i - /I/	.14 - (-.02)	.16*	
k - /k/ : e - /ɛ/	.13 - (-.03)	.16*	
v - /v/ : l - /l/	.17 - 0	.17*	
sh - /ʃ/ : f - /f/	.10 - (-.08)	.18*	

† Medium strength mediators used

$^{\Delta}$ Medium strength mediators not used

* Results are significant at the $p < .05$ level or better.

$\hat{\Psi}$ = actual learning gain difference.

Ψ = critical value of difference required at the .05 level.

TABLE XI

POSTTEST THREE MLAP INTERACTION LEARNING GAINS ACHIEVED BY THE FOUR TREATMENT CONDITIONS* (TC's) INVOLVED FOR THIRTY-TWO LETTER-SOUND ASSOCIATIONS (LSA's)

LSA	MEAN LEARNING GAINS			
	NMLN	LNM	MNL	ML
a - /æ/	.21	.07	.21	.17
ay - /e/	.04	.10	.06	.11
b - /b/	.15	.15	.24	.35
ch - /tʃ/	.09	.09	0	.15
d - /d/	.09	.13	.11	.15
e - /e/	.22	.02	.02	.16
ee - /ɪ/	.02	.15	.15	.28
f - /f/	.21	.17	.10	.15
g - /g/	.13	.09	.07	.18
h - /h/	.15	.04	.09	.07
i - /ɪ/	.11	.15	.11	.11
I - /dʒ/	.19	.24	.29	.13
k - /k/	.19	.18	.22	.41
l - /l/	.13	.09	.04	.19
m - /m/	.13	.13	.02	.20
n - /n/	0	.07	.07	.18
o - /ɑ/	0	.20	.28	.17
oa - /o/	.09	.15	.09	.10
oo - /u/	.13	.13	.11	.22
ow - /ao/	.13	.11	.15	.20
oy - /ɔ/	.05	.04	.04	.13
p - /p/	.17	.13	.11	.13
r - /r/	.13	.15	.15	.20
s - /s/	.09	.07	.23	.26
sh - /ʃ/	.08	.05	.17	.17
t - /t/	.20	.11	.13	.18
th - /ð/	.03	.06	.09	.15
u - /ə/	.05	.07	.08	.18
v - /v/	-.02	.09	.17	.22
w - /w/	.07	.07	.05	.15
y - /j/	.09	.06	.05	.24
z - /z/	.16	.09	.10	.30

* 1) Neither medium nor low mediators used (NMNL)
2) Low but not medium mediators used (LNM)
3) Medium but not low mediators used (MNL)
4) Both medium and low mediators used (ML)

difference values that the ML values seem to be consistently as high or higher than the NMNL values within particular LSA's. In a similar manner, it may be noted that LNM tends to be very close in value (with rare exceptions) to the NMNL values opposite them. Some of the MNL values for particular LSA's, however, seem to be distinctly superior to NLNM, some are very close in value, and others seem to be somewhat inferior.

Further inspection reveals that all of the LSA's which were involved in significant differences in the Table X planned comparisons conducted for the posttest three MAP interaction also contributed to the significant effects of the posttest three MLAP interaction. Table XII presents the planned comparisons of learning gain differences between the NMNL and the MNL treatment conditions of the MLAP interaction for these particular LSA's. The following learning gain difference comparisons all achieved actual values ($\hat{\Psi}$) greater than the critical value ($\Psi = .13$) necessary to indicate statistical significance at the $p < .05$ level: b - /b/ compared with m - /m/ ($\hat{\Psi} = .20$), ee - /i/ with ch - /tʃ/ ($\hat{\Psi} = .22$), s - /s/ with p - /p/ ($\hat{\Psi} = .20$), o - /ɑ/ with i - /I/ ($\hat{\Psi} = .28$), k - /k/ with e - /ɛ/ ($\hat{\Psi} = .23$), v - /v/ with l - /l/ ($\hat{\Psi} = .28$), and sh - /ʃ/ with f - /f/ ($\hat{\Psi} = .20$).

TABLE XII

PLANNED COMPARISONS BETWEEN THE MEAN LEARNING GAIN DIFFERENCES OF THE NLNM AND THE MNL TREATMENT CONDITIONS OF THE POSTTEST THREE MLAP INTERACTION FOR PARTICULAR LETTER-SOUND ASSOCIATIONS (LSA's)

LSA's COMPARED	LEARNING GAIN DIFFERENCE	$\hat{\Psi}$	Ψ = .19
b - /b/ : m - /m/	.09 - (-.11)	.20*	MSerr = .0597
ee - /i/ : ch - /tʃ/	.13 - (-.09)	.22*	n = 54
s - /s/ : p - /p/	.14 - (-.06)	.20*	
o - /ɑ/ : i - /I/	.28 - (0)	.28*	
k - /k/ : e - /ɛ/	.03 - (-.20)	.22*	
v - /v/ : l - /l/	.19 - (-.09)	.28*	
sh - /ʃ/ : f - /f/	.09 - (-.11)	.20*	

† Neither low nor medium strength mediators used.

Δ Medium but not low strength mediators used.

* Results are significant at the $p < .05$ level or better.

$\hat{\Psi}$ = actual learning gain difference.

Ψ = critical value of difference required at the .05 level.

DISCUSSION

The significance of the factor Sch main effect in all three posttests indicates that there were between-school differences as far as knowledge of letter-sound associations is concerned. However, the lack of significance in any of the SchP interactions which separate gains from prior knowledge indicates that, for the present study in which seven-eighths of the observations were conducted under the influence of imagery facilitation, few differences in learning gains could be attributed to population differences between schools. This seems to support Rohwer's (1971) conclusion that learning strategies involving imagery are capable of overcoming population differences.

The significance of the factor A main effect in all three posttests indicates that not all letters were equally known to the children. This is in accord with Bridge's (1968) findings that LSA's are learned with different levels of difficulty. Moreover, the extremely high significance of the AP interaction in all three posttests is a strong indication that under the influence of visual mediation, some LSA's are more easily learned than others.

The extremely high significance of the factor P main effect in all three posttests simply means that

learning occurred. In interaction with other factors, factor P takes prior knowledge into account thus enabling the isolation of gain scores. Without factor P, the separation of experimental gain from prior knowledge would be quite impossible. The interactions which do not involve factor P (specifically, the significant effects of interactions HSch, MA, SchA, HLA, MLA, HMLA, and HLSchA from posttest one, HSch, SchA, HLA, HMLA, HLSchA, and MLSchA from posttest two, and HSch, SchA, HML, HLA, MLA, HLSchA, and MLSchA from posttest three as listed in Table I) defy meaningful interpretation and consequently are of little import to this study. A central reason for including these interactions into the analysis of variance and for determining their various effects was to account for and to extract extraneous sources of variances which might influence the outcome of the investigation if not so controlled.

The main interest of this study is in the comparative performance of the interactions involving factors H, M, and L in combination with factors P and A (i.e., HP, MP, LP, HMP, HLP, MLP, HMLP, HAP, MAP, LAP, HMAP, HLAP, MLAP, and HMLAP). These are the interactions of interest in determining the veracity of the five experimental hypotheses which were proposed.

Figure 11 graphically presents some hypothetical learning gain relationships (between the eight mediator treatment conditions) which the experimental results might be expected to yield under certain interpretations of the first four experimental hypothesis. These five hypotheses construct learning gains relationships as follows:

11a) if all mediators were superior to rote but equally facilitative,

11b) If facilitation varied directly with mediator strength (but not number),

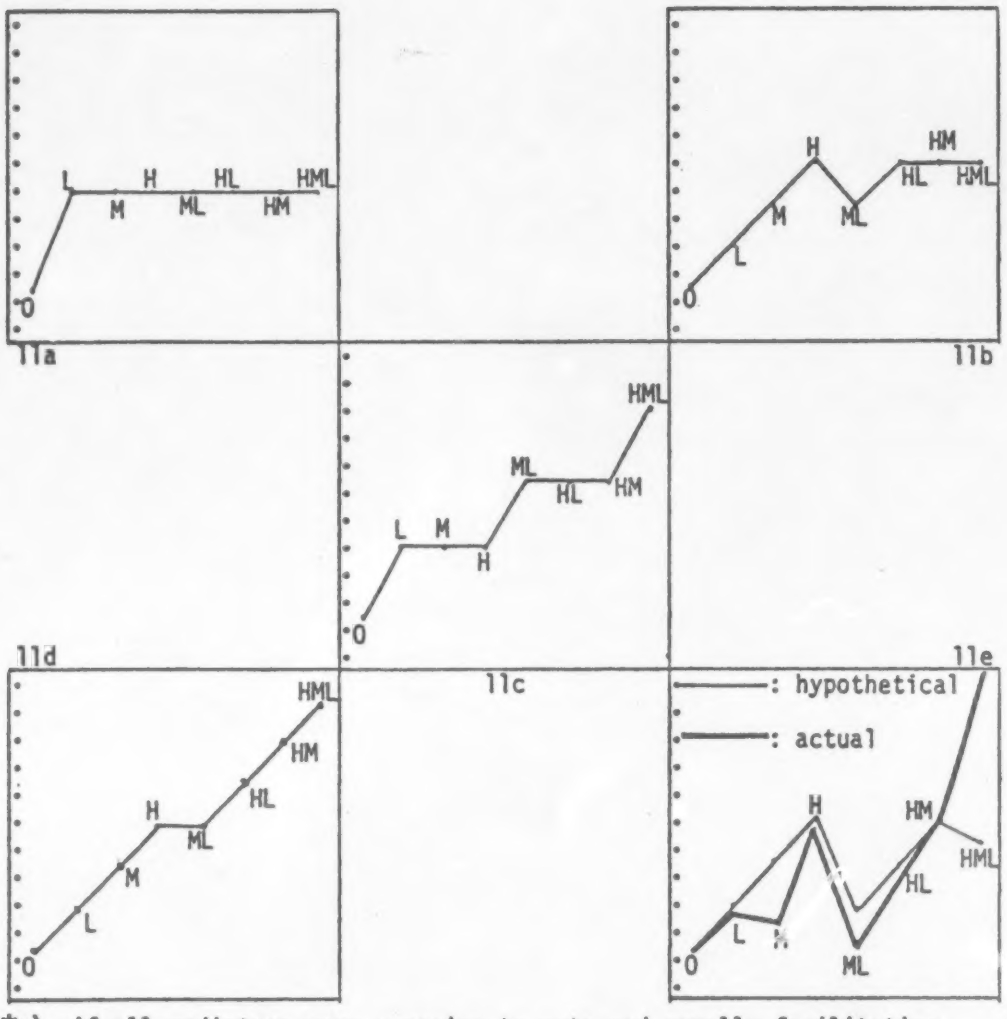
11c) if facilitation varied directly with mediator number (but not strength),

11d) if the effects of additional mediators were additive relative to their strength,

11e) if additional mediator effects were additive for strong mediators, neutral for medium strength mediators and subtractive for weak mediators.

The graphs will be individually reintroduced and further explained during the discussion of appropriate experimental hypotheses.

Hypothesis one, the use of mediating imagery will facilitate learning, is supported by the evidence, but probably requires further qualification. According to



*a) if all mediators were superior to rote and equally facilitative.
b) if facilitation varied directly with mediator strength (but not number).
c) if facilitation varied directly with mediator number (but not strength).
d) if the effects of additional mediators were additive relative to the strength of each.
e) if the effects of additional mediators were additive for strong, neutral for medium, and subtractive for low strength mediators with actual learning gain relationships of posttest two superimposed.

Figure 11. Hypothetical learning gain relationships* of the eight treatment conditions: no mediators used (O), low (L), medium (M) or high (H) strength mediators used, combination of medium and low (ML), high and low (HL), high and medium (HM), and high, medium and low (HML) strength mediators used.

a rigid interpretation of hypothesis one as stated, the learning gains of all mediator treatments (HP, MP, LP, HMP, HLP, MLP, HMLP) would be expected to be superior to those of the no mediator (rote) treatment. If all mediators were superior to rote and equally facilitative, the graph of learning gains might be expected to look something like Figure 11a. However, a major supposition of the present study, inherent in the statements of hypotheses two, three, and four is that only if mediators are sufficiently strong or present in sufficient numbers could significant or even positive facilitation be predicted. These latter interpretations seem to be supported by the data.

By analyzing the significant HMLP interactions for each of the three posttests by means of post hoc tests (Tables IV, V, and VI), the various mediator treatment conditions could be directly compared with the no mediator condition. The results of the Tukey post hoc tests for all three posttests show only the high mediator (H), high-medium mediator (HM), and high-medium-low mediator (HML) treatment conditions to be significantly superior ($\hat{\Psi} \geq \Psi$) to the no mediator (rote) treatment condition ($p < .05$). Figure 9 and the Figure 10 graphs clearly show these relationships. Further, Figures 10a, 10b, and 10c also reveal mediator conditions (ML and M) which performed at almost exactly the same level as rote. Therefore, our understanding

should probably be amended as follows: the use of mediated imagery will facilitate learning provided that the mediating images are sufficiently strong.

Hypothesis two, there will be a significant positive relationship between the strength of a mediating image and learning efficiency, is also supported by the evidence. A study of the HP, MP, and LP interactions (Table 2) provides much of the basis for this conclusion. In all three posttests those treatment conditions which contained the strong mediator (H) were superior ($p < .000$) to those treatment conditions which did not contain the strong mediator (NH). These findings are demonstrated by the graphs in Figure 7b. Figure 7a presents a graphic comparison of the three mediator strengths. The superiority of the high strength mediator is corroborated through a post hoc identification of the sources which contribute to the significant HMLP interactions manifested in all three posttests. Such analyses permit direct comparison of the effects of H, M, and L. As has been previously stated in the discussion of hypothesis one, Tukey's post hoc analyses (Tables IV, V, and VI) of these HMLP interaction effects reveal the statistical superiority ($p < .05$) of the high mediator in all three posttests (posttest one: $\hat{\Psi} = .065$, $\Psi = .052$; posttest two: $\hat{\Psi} = .071$, $\Psi = .056$; posttest three: $\hat{\Psi} = .071$, $\Psi = .056$). M and L fail to manifest any

such significant effect. It is mainly upon this performance differential relative to rote that the contention of H's superiority over both M and L is supported.

There is also other corroborating evidence albeit less conclusive. Under the conservative Tukey post hoc mean gains comparison test (Tables IV, V, and VI), the H condition performed consistently and substantially higher than either the M or the L treatment conditions (see Figures 10a, 10b, and 10c) although achieving statistical significance over only M and then only in posttest three (Table VI: $\hat{\Psi} = .069$ and $\Psi = .056$ at the .05 significance level). If facilitation varied directly with mediator strength only, a graph of the learning gains might resemble Figure 11b. A visual inspection of Figures 10a, 10b, and 10c reveals similarity in form to Figure 11b with the exception of the relative weakness of M and of the greater actual strength of HML (which, although stronger than anticipated does not refute hypothesis two).

The only statistical indication that medium strength mediators may be generally stronger than weak mediators is shown by the significant MP interaction of posttest three as revealed in Table II ($F = 5.69$, $p < .018$). Such a tendency toward superiority by M is not revealed through the post hoc analysis of the HMLP interactions (Tables IV, V, and VI). Although there is no statistically

significant difference between the M (121) and the L (112) treatment conditions, a brief glance at the graph (Figure 9) which compares mean gain scores of each of the eight treatment conditions (no-mediator, 111; L, 112; M, 121; H, 211; ML, 122; HL, 212; and HML, 222) shows that L (112) actually fared slightly but consistently better than M (121). This unexpected weak performance by the M mediator will be discussed in Chapter VII (Summary, Conclusions, Limitations, and Implications). In summary, hypothesis two seems to hold for all mediator strengths and combinations of mediator strengths except for the medium strength mediators.

In addition to predicting H > M > L, hypothesis two would also predict that HM > HL > ML. Support for this contention arises from much the same sources and logic as those manifested in behalf of H over M and L. In the direct treatment-by-treatment post hoc comparison test conducted upon the component of the HMP interaction, HM manifested statistical superiority at the .05 level over ML in posttests one ($\hat{\Psi}$ = .063, Ψ = .054) and two ($\hat{\Psi}$ = 072, Ψ = .056). HM narrowly missed achieving such significance over both HL ($\hat{\Psi}$ = .052, Ψ= .056) and over ML ($\hat{\Psi}$ = .055, Ψ = .056) in posttest three. In that same series of post hoc tests HM succeeded (and HL and ML failed) in manifesting superiority ($p < .05$) over rote in all three posttests (posttest one: $\hat{\Psi}$ = .062, Ψ = .052; posttest two: $\hat{\Psi}$ = .074,

Ψ = .056; posttest three: Ψ = .087, Ψ = .056). These relative performances of HM, HL, and ML compared to rote also support superiority of HM over HL and ML. The graphs of Figure 9 and Figures 10a, 10b, and 10c indicate a consistent HM > HL > ML relationship. Further evidence comes from a comparison of the ANOVA interaction effects of HMP, HLP, and MLP, which may be seen in Table I. HMP performs consistently close to statistical significance in all three posttests ($p < .085$, $p < .051$, $p < .017$, respectively) while HLP and MLP are correspondingly far off, except for MLP ($p < .057$) in posttest three.

In summary, hypothesis two seems to hold for all mediator strengths and combinations of mediator strengths except for the medium strength mediator.

Hypothesis three, <u>there will be a significant positive relationship between the number of mediating images and learning efficiency</u>, cannot be completely accepted or rejected. If facilitation varied directly with mediator number only, learning gains of the eight treatment conditions might follow a pattern resembling Figure 11c. A brief inspection of Figures 10a and 10b will show that one mediator is approximately as good as two (HM ≈ H, HL ≈ L, with ML faring no better than rote and actually somewhat weaker than M). In Figure 10c (the graph of posttest three) the performance of HM, HL, and ML improves

somewhat relative to the performances of H, M, and L. Still, however, HM approximates H, HL approximates H, with ML becoming slightly stronger than M.

These similarities are supported by the statistical evidence. Comparisons of the mean gain differences between HM and H, between HL and L, and between ML and M in Tables IV, V, and VI (posttests one, two, and three, respectively) not only show no significance but indicate strong similarities in performance. In posttests one and two a one-mediator treatment condition (H) actually performed significantly better ($p < .05$) than a two-mediator (ML) condition ($\hat{\Psi} = .069$, $\Psi = .056$). Therefore, doubt must be cast on the notion of unqualified superiority by a larger number of mediators. Two mediators at least, do not seem to increase facilitation over one mediator when mediator strength is controlled.

In those same three tables (IV, V, and VI), the compelling level of significant differences attained (minimum value of $\hat{\Psi} = .101$, maximum value of $\Psi = .056$ for $p < .05$) by the three-mediator treatment condition (HML) over the no-mediator, one-mediator and two-mediator treatment conditions, however, would seem to support facilitation as some function of mediator number. Still, the experimental hypothesis as originally constructed may be rather simplistic. An explanation which only included mediator

strength would not be sufficient to account for the magnitude of the gains achieved by adding a low-strength mediator (L) to HM considering the performances of HM and of L as separate entities. Something other than a simple, linear relationship which varies directly with mediator number is almost surely involved. Considering the evidence, therefore, a suggested modification of hypothesis three should probably include criteria for predicting the number of additional mediators necessary to register significant differences.

Like experimental hypothesis three, hypothesis four, there will be a significant interaction effect between mediator strength and number such that learning efficiency will increase as mediator strength and number increase, cannot be completely accepted but may not be rejected. If hypothesis four were valid, facilitation might be manifested in two possible patterns. The effect of additional mediators could be additive or subtractive; that is, the addition of a weak mediator may either increase or decrease learning when paired with other mediators. If the effects of additional mediators are additive, low strength mediators will increase the facilitation effects of high strength mediators. In the case of additive effects, the mean learning gains of the eight treatment conditions (Figures 10a, 10b, 10c) would be

expected to approximate Figure 11d. If additonal mediator effects were additive for strong mediators, subtractive for weak mediators and neutral for medium strength mediators, a graph of the learning gains could look something like Figure 11e.

For descriptive purposes only the graph of the posttest two mean learning gains for each of the eight treatment conditions has been superimposed upon Figure 11e. It may be seen that Figure 11e very closely resembles the results realized in posttest two with the exception of HML. However, the actual posttest two value of treatment condition HML more closely approximates the hypothetical HML value in Figure 11d. Somehow when three mediators are involved, mediator effects become additive. Perhaps as the number of mediators becomes sufficiently large, enough will be available to serve individual learning requirements.

Figures 10a, 10b, and 10c (posttests one, two, and three, respectively) clearly show facilitation rising as mediator strength increases from L to H and from ML to HL to HM. The only exception to this generalization is the behavior of M in all three posttests. No such rise in facilitation is present in the transition from the strong one-mediator treatment condition (H) to the weakest two-mediator treatment condition (ML). The evidence is quite to the contrary in the form of a sharp drop in facilitation

between H and ML. Pairing a weak mediator (L) with a strong mediator (H) seems to dilute the effect of H. As the second mediator increases in strength (pairing M with H), facilitation is seen to increase.

Evidence favoring mediator number over strength comes from the somewhat stronger retention values (rate of retention table contained in Table VII) of the two-mediator combinations relative to the one-mediator treatment conditions. An alternate explanation to the additive and subtractive explanations posed above is that learning is a function of mediator strength and that retention is a function of mediator number. In this regard, the three-mediator treatment condition, HML, shows the strongest percentage of retention with two-mediator conditions next strongest. Strong mediators, then, might contribute to best initial learning; increased mediator number might improve retention over time by enhancing some factor of memorability such as an increased number of cues.

For the present it is possible for hypothesis four to be true in the light of current evidence. However, the issue remains far from resolved and many, more fine-grained questions need to be answered.

Hypothesis five, <u>there will be no interaction effect between specific letter-sound associations and the strength or number of mediating images used</u>, may be

accepted with one notable exception. It was originally supposed that different LSA's under the influence of a particular treatment condition would benefit rather evenly relative to any other particular mediated treatment condition. There were previously found to be differences in the ease of learning different LSA's (Bridge, 1968). No mediation effect was expected to overcome these apparently inherent differences. However, each particular mediated treatment condition was expected to deliver a rather consistent facilitation effect relative to the performance of any other treatment condition between particular LSA's. Table VIII indicates that seven of the possible twenty-one interactions which would have been sensitive to the presence of such effects did manage to detect significant differences. It should be noted that all seven of the interactions involved the medium strength (M) mediator. Subsequent analyses by planned comparisons indicated that the medium strength mediator was indeed the probable source of the problem.

It has been shown that the significance of the posttest three MAP and MLAP ANOVA interactions (Tables X and XII, respectively) probably stemmed from the uneven facilitation of the medium strength mediators. The hypothesis seems to hold for the strong (H) and the weak (L) mediators except where M was involved in the interaction.

As will be subsequently suggested, the wavering performance of M probably stems from the manner in which mediator strength was operationalized and as such constitutes an operational rather than a theoretical problem. It is therefore recommended that hypothesis five be essentially accepted for the strong and weak mediators under the system presently used to operationalize mediator strength.

SUMMARY, CONCLUSIONS, LIMITATIONS, AND IMPLICATIONS

In summary, motion picture film was used in this research project to study the role of visual imagery in the learning of letter-sound associations by kindergarten children. Five specific questions were investigated: (1) does mediating imagery affect learning, (2) does mediator strength affect learning, (3) does the number of mediating images affect learning, (4) is there an interactive effect between mediator strength and number, and (5) is there an interactive effect between specific letter-sound associations and mediator strength and number.

Mediator strength was operationalized as follows. Associations to letter shapes and to letter sounds were collected from kindergarten-aged children. Four mediating pictures, suggested by combining graphemic associations with those of corresponding phonemes, were created for each letter-sound association (LSA). Mediator strength was subsequently determined by children's ratings of each picture's relative capacity to imply the sound of the particular letter which the picture was designed to represent.

Eight treatment conditions (TC's) were used: (1) no-mediator used, (2) low (L), (3) medium (M), and (4) high (H) strength mediators used, combinations of

(5) medium and low (ML), (6) high and low (HL), (7) high and medium (HM), and (8) high, medium and low (HML) strength mediators used.

The learning materials consisted of 256, thirty-seven second, 8mm sound films, which were identical in aural and visual format, differing only in the particular mediators used. A two-and-one-half-minute task orientation film preceded the learning task.

Subjects were 216 kindergarten children from the Austin (Texas) Independent School District. Each of three schools furnished eight groups of nine children and each of these groups was randomly assigned to one of the eight TC's. Each group was presented thirty-two LSA's, eight a day for four consecutive days. Each child was individually pre- and posttested. Three posttests were conducted: immediate, twenty-four hour delayed recall, and two-week delayed recall.

The results of the data analyses revealed significant learning gain differences at the .05 level or better in favor of the three-mediator TC over all of the other seven mediator conditions in all three posttests. For only the one- and two-mediator conditions, however, mediator strength appeared to be more influential than mediator number. Two mediators performed no better than one when mediator strength was controlled, and only the strongest one- and two-mediator TC's, H and HM, achieved statistical superiority

at the .05 significance level over the no-mediator treatment. It seems that both mediator strength and number are important, but precise criteria under which both may be expected to facilitate learning are not yet at hand. Further research is required to improve the method of operationalizing mediator strength and to vary mediator strength and number more extensively.

In conclusion, the experimental hypotheses have basically been substantiated provided that some slight but important modifications are made. Mediation does provide effective facilitation provided that the mediators are sufficiently strong. Facilitation is almost certainly a function of mediator strength and the number of mediators is probably a factor in facilitating learning provided that there are a sufficient number of mediators to manifest differences. The evidence does indeed seem to indicate a relationship between mediator strength and number; however, acceptance of the hypothesis requires a more detailed account of the strength-number relationship. Weak mediators, which may be slightly facilitating in themselves, probably manifest a negative effect when coupled with a strong mediator. That is, the facilitation effect of H paried with L will probably be lower than only H especially if presentation of L usurps time which would otherwise be alloted to H.

Beyond a certain number (the determination of a criterion number is not yet clear) it is probable that

extra mediators exert very powerful facilitative effects. Particular treatment conditions exert consistent effects across LSA's relative to the performance of other treatment conditions except for those which involve the medium strength mediator.

While the present study was in progress, questions were raised in regard to the effect of the present materials upon different populations. This led to the initiation of another study (Boeker and Bolz, 1975) which was conducted upon a mixed age population (mean age, approximately twenty-six) of mental retardates from the Austin State School in Austin, Texas.

This other study involved only twelve subjects, eight LSA's, two mediator strengths (high and low), four treatment conditions, and thirty-two of the experimental films used in the present study. Thus, the Boeker and Bolz study subsequently initiated was completed before the present one (involving 216 subjects, thirty-two LSA's, three mediator strengths, eight treatment conditions, and 256 films) could be completely analyzed and reported.

Boeker and Bolz operationalized mediator strength in a manner similar to that used in the present study. It will be recalled that the phoneme was presented in the presence of the four mediators and the children were requested to rank order the mediators based upon how well

the pictures implied the sound. In the Boeker and Bolz study, E presented only the mediating pictures without pronouncing the phoneme and subjects were requested to verbally report what they saw.

Those mediators which elicited the appropriate phonemic sound from the most subjects during their narrative accounts were designated as strong mediators. Low strength mediators were those pictures which were recognized but which did not elicit any sound relating to the phoneme during the subjects' verbal descriptions. Medium strength mediators were not used.

The study was, therefore, comprised of four treatment conditions: no mediator, low strength mediator (L), high (H), and both high and low mediators together (HL). The mediators selected as high and low strength for a particular LSA in the Boeker and Bolz investigation often differed from those so designated in the present study. Despite this difference, Boeker and Bolz concluded that H was significantly more facilitative than the no mediator condition but that L and HL were not. These results tend to confirm the conclusions drawn in this report. Strong mediators may be relied upon to facilitate learning, weak ones may not. Also, a strong and a weak mediator together (HL) may not be expected to be more effective than one strong mediator and may even be less reliable. For a

controlled presentation time and for limited verbal and visual (no movement) explication, at least, the weak mediator again seems to dilute the potency of H when both are used together. One notable exception to the present results in the Boeker and Bolz study was that the performance of subjects exposed to L varied significantly between particular LSA's. In the present study this type of problem was encountered with M. Thus, with respect to all of the findings of Boeker and Bolz, it is possible to report that the present study has already been replicated in part.

Any final assessment of the present study should probably require more than simple replication no matter how reassuring such replication may be. Insights and experiences, which occurred as by-products of the present investigation, point to several issues which future studies should take into account and attempt to resolve.

The schools used in this study were not experimentally selected at random. Selection was subject to modus operandi indigenous to an urban public school system. For example, certain principals were polled (by the Austin Independent School District) to determine a willingness to participate. How many were polled or how many responded positively is not known. What is known is that those schools that did participate had principals who were positively oriented to the project. This might have introduced

a biasing factor which could possibly limit the ability to generalize the overall levels of facilitation to other populations. However, since all treatment conditions were equally affected, any such bias which might have been present would probably not have interfered with the comparative facilitation effects between treatment conditions.

According to the pretest scores, the children involved in the study possessed a rather formidable beforehand knowledge of some letter-sound associations. Two factors undoubtedly contributed. First, testing did not commence until immediately after the Christmas-New Year's vacation. In the first four months of the school year, the kindergarten students were undoubtedly exposed to letter-sound associations. Secondly, participating teachers were necessarily aware that their classes would be involved in a learning experiment involving LSA's. A desire to promote a good showing may have inordinately stimulated interest in LSA learning. The technique of separating learning gains did overcome the effect of prior knowledge. However, it is recommended that future studies of this nature commence as close to the beginning of the school year as possible to insure as naive a learning population as possible.

It should also be noted that the subjects used were predominantly middle-class, Caucasian children.

Materials which were tailor-made to a high socio-economic status (SES) population should not be expected to be especially facilitative to Black or Chicano learners (Baratz, 1970). However, Rohwer (1971) demonstrated the power of imagery to overcome ethnic and SES handicaps in instructional situations. When imagery strategies to facilitate learning were supplied, the learning differences between high-SES White children and low-SES Black children in grades K through three were eliminated. Additionally, Hall and Turner (1974) demonstrated that although ghetto culture and language may handicap expression in standard American English, understanding is not impaired. Therefore, although present results should be generalized with great caution to low-SES minority learners and replication using such populations should be encouraged, the possibility of generalizing present results to other populations is submitted as not entirely without merit.

The treatment designated to be the control condition (the no-mediator condition) might have produced more learning than expected from a so-called rote learning condition. The no-mediator treatment conditions were designed to match the experimental treatments feature-by-feature, differing only in the fact that mediators were excluded (as may be seen in Figure 6). However, shot two, which

followed a shot of a white letter in a green field, consisted of a blank white field. This combination of shots had the effect of creating an after-image which was not experienced in the experimental treatments. Although the use of an alternative control condition which would consist of a single shot containing a black letter superimposed upon a plain white background would have solved this problem, such alternative control films would be without the desirable feature of controlling all stimuli not related to the experimental variables being manipulated. It is therefore suggested that related future experiments either use both types of control conditions just described or that the no-mediator films used in the present study be redesigned.

A central assumption underlying the present study is that all mediators are not equally facilitative, and further, that differences in facilitation strength may be at least partially operationalized in terms of existing cognitive structures. The fact that the high strength mediators (H) achieved consistently greater gains than medium (M) and low (L) strength mediators would seem to justify these basic assumptions. The inconsistent performance between particular medium strength mediators, principally manifested in the significant MAP and MLAP

interaction effects (Tables IX and XI, respectively), do seem to point up a weakness in the method of operationalizing mediator strength.

Medium strength mediators were so designated because their total points, scored during the rank-ordering process, fell between the highest and lowest totals. Such a medium point total was not achieved because the mediator involved received only middle choice votes. Very often mediators achieved a medium ranking because their first place votes were counterbalanced by last place ratings. It was this "split personality" of the medium strength mediators which most likely accounted for their uneven performance. In the Boeker and Bolz study, L suffered the same problem. It should be noted that their low strength mediator was recognized by the subjects, and although the phoneme was not overtly expressed during the description of the mediator, a latent capability to understand the mediator in the context of the phoneme might still have been present. Such a condition might have made some low-strength mediators inordinately strong for some learners.

Simple superiority in a weighted tally count, such as in the present study, does not insure that a mediator will necessarily be highly facilitative relative to rote, only that such a mediator will probably be more facilitative than the other mediators with which it competed directly in the ratings. The system of rating mediator

strength relative to the performance of competing mediators intuitively seems to be less reliable than a rating system in which strength is determined against some standard measure. Such a standard measure does not, of course, currently exist. Until a mediator rating system which uses a fixed standard is devised, precise predictions may not be possible. Until then, however, the present rating system does seem to provide a validated method by which strong and weak mediators may be consistently identified.

Although significant differences in facilitation were achieved, the magnitude of the gains actually registered by the various mediators were probably modest compared to their instructional potential. It should be remembered that the present materials were not designed to be efficient teaching vehicles, but to be experimental films which were intentionally designed to limit and to control other possible sources of facilitation. Furthermore, these films were intended to establish a baseline against which the effects of increased facilitation techniques could be compared.

The present results are probably sufficiently encouraging to warrant continued investigation. However, these results were obtained with but a single format, with aural stimulation virtually limited to pronunciations of the phoneme, and with visuals restricted to non-moving

images. Additional verbal and visual information almost surely has the potential to increase facilitation. For example, verbal identification of a relatively unfamiliar (weak) mediator should improve learning in some instances. Animated techniques which clarify the relevance of mediator shape to the grapheme could also be helpful. However, the particular attributes of visual and verbal explication, individually and in combination, which might tend to maximize facilitation is not yet known. It is hoped that the present procedures, results, and replicable presentation design, which is capable of being systematically varied, will facilitate future investigations in these directions.

Appendix A

THIRTY-TWO LETTER-SOUND ASSOCIATIONS

Grapheme	Phoneme*	Examples of English pronunciation
a	æ	am
ay	e	late
b	b	bat
ch	tʃ	child
d	d	dark
e	ɛ	get
ee	i	see
f	f	fat
g	g	go
h	h	hat
i	I	in
j	dʒ	jury
k	k	cat
l	l	let
m	m	met
n	n	net
o	ɑ	hot
oa	o	go
oo	u	rule
ow	aʊ	cow
oy	ɔ	boy
p	p	part
r	r	rest
s	s	send
sh	ʃ	ship
t	t	ten
th	ð	that
u	ə	but
v	v	very
w	w	went
y	j	yes
z	z	zoo

* symbols based upon the International Phonetic Alphabet as described by Brosnahan and Malmberg (1970).

APPENDIX B

LIST OF MENTAL IMAGES MOST FREQUENTLY ASSOCIATED WITH THIRTY-TWO GRAPHEMES AND WITH THIRTY-TWO CORRESPONDING PHONEMES AS PROVIDED BY PRESCHOOL AND KINDERGARTEN CHILDREN

grapheme-phoneme pair	associated image (and frequency of association) provided for grapheme	phoneme
a-/æ/	stick and ball (5) apple (4)	sheep (11) apple (2) at (4) hat (2)
ay-/e/	thing hits stick on a tree (5)	apple (5) egg (3) snake (2)
b-/b/	head (10) circle (6) stick hits ball (3) upside down p (2)	bee (8) boo (3) bug (2)
ch-/tʃ/	horseshoe and chair (5)	train (29) chicken (5)
d-/d/	chair (7) hitting ball (2)	dog (6) duck (4)
e-/ɛ/	head and mouth (3)	sheep (3) Ed (2) dog (2)
ee /i/	open mouths (5)	eagle (9) scared (5)
f-/f/	thing with handle (6)	fun (4) fit (2) field (2)
g-/g/	head (11) circular design (4) mouth (2)	good (4) go (2) grapes (2)
h-/h/	chair (9) house (5) bridge or tunnel (4)	tired (21) horse (2) hat (2)
i-/ɪ/	person (6) stick and ball (5) train (2)	it (8) eat (3) sheep (2)
j-/dʒ/	cane (4) hook (4) design (2)	John (4) train (2) jug (2) jet (2)
k-/k/	pointed object in contact with a straight object (11)	impact (7) kangaroo (3) key (3)
l-/l/	stick (7) rope (6) flower (5)	lion (5)
m-/m/	bridge (8) mountains (5) doorway (2)	good (16) cow (6) thinking (4) motor (2)
n-/n/	door (12)	in (6) motor (3) Nan (2) bee (2)
o-/ɑ/	head (22) circle (10) ball (7) wheel (6) eye (5) egg (4) zero (3) clock (2)	Dr. says, "say /ɑ/." (18) hurts (2) good (2)
oa-/o/	impact involving eyes or balls (5)	surprise (11) dismay (2) toy (2)
oo-/u/	eyes (25) wheels (10) heads (10) glasses (6) car (3) windows (2)	owl (11) unpleasant (12) ghost (2)
ow-/aʊ/	ball thrown at something (8)	hurt (43)
oy-/ɔ/	ball hits tree (4)	pig (15) boy (5) bird (2)
p-/p/	head (6) circle and handle (3) ten (2) window (2)	things that go pop (11)
r-/r/	hook (4) doorway (3)	car (15) growl (11)
s-/s/	snake (23) slide (3)	snake (45)
sh-/ʃ/	snake and chair (5)	be quiet (37)
t-/t/	cross (15) hammer (3)	tapping (6) clock (3) turtle (2)
th-/ð/	cross and chair (7)	bee (8) the (3) that (2)
u-/ʌ/	[one-of-a-kind associations only]	thinking (7) up (3)
v-/v/	inverted house (14) wings (5) triangle (4)	bee (6) drill (3) violet (2)
w-/w/	mountains (5) triangles (3)	bark (9) wolf (4) wind (3) ghost (2)
y-/j/	triangle (3) rooftop (2)	yes (9) disgust (5)
z-/z/	lightning (5) sideways N (3) two triangles (3)	bee (27) sleeping (3) zebra (3) saw (2)

APPENDIX C

LISTING OF THE FOUR PICTURES PRODUCED TO MEDIATE EACH OF THE THIRTY-TWO LETTER-SOUND ASSOCIATIONS (LSA's), THE RANKING TALLIES, TOTAL POINTS SCORED AND RANK DESIGNATION OF THE HIGH (H), MEDIUM (M), AND LOW (L) STRENGTH MEDIATORS

LSA	MEDIATOR	RANK	TOTAL POINTS SCORED	RANKING TALLIES 1	2	3	4
a - /æ/	rat	L	73	7	8	7	12
	ant	•	89	8	11	8	7
	sheep	H	91	10	7	10	7
	apple	H	87	9	8	9	8
ay - /e/	hearing aid	•	80	8	10	5	7
	cheerleader	H	90	11	7	7	5
	ape	L	57	5	5	7	12
	grapes	H	79	6	7	11	6
b - /b/	bug	H	74	6	8	10	8
	ball	H	93	11	6	10	5
	baby	L	71	8	5	8	11
	bat and ball	•	92	2	13	4	8
ch - /tʃ/	choo choo	H	123	17	6	10	4
	sneezing	H	82	7	11	7	12
	horseshoe, chair	L	65	2	11	10	14
	chicken	•	102	11	9	11	7
d - /d/	dog	H	129	17	10	7	2
	stupid person	L	57	5	6	7	16
	typewriter	•	71	4	9	12	9
	ding dong	H	93	10	9	8	7
e - /ɛ/	eskimo	L	68	7	9	3	13
	deaf ear	•	90	8	10	10	4
	old man cackle	H	69	5	8	10	9
	elephant	H	93	12	9	5	6
ee - /i/	eating	H	80	9	7	7	10
	shriek at mouse	•	82	7	11	11	4
	frightened eyes	H	88	11	7	6	9
	eagle's cry	L	72	6	8	9	10
f - /f/	fountain	H	94	10	10	7	4
	bike pump	H	72	6	8	9	8
	cat spitting	L	57	6	5	6	14
	fan	•	87	9	8	9	5
g - /g/	baby	L	73	6	11	5	12
	gargling	H	92	9	9	10	6
	goldfish	H	85	8	11	6	9
	gate	•	90	11	3	13	7
h - /h/	panting in chair	H	91	16	1	4	9
	haystack	L	56	4	4	12	10
	house	•	83	7	12	6	5
	horse	H	80	3	13	8	6
i - /ɪ/	monkey	H	91	10	9	10	3
	witch	L	66	8	6	4	14
	candle	•	81	9	8	6	9
	fox	H	76	5	8	12	6
j - /dʒ/	fish hook, bobber	H	66	5	7	10	7
	jump rope	•	80	9	9	4	7
	cane	L	52	4	4	10	11
	jaw breaker	H	92	11	9	5	4
k - /k/	boat crash	L	84	8	6	13	9
	soldier marching	H	96	12	8	6	10
	arrow & target	H	88	8	10	9	9
	ax hits tree	•	92	8	12	8	8
l - /l/	lick	•	97	11	12	3	6
	line	H	100	13	9	4	6
	log	H	65	4	7	12	9
	one lion	•	58	4	4	13	11
m - /m/	mittens	H	79	6	11	8	9
	cow	•	100	12	8	8	6
	mask	L	47	5	4	10	15
	twin cones	H	104	13	11	8	4
n - /n/	nose	•	91	10	7	10	4
	creaking door	L	60	6	4	9	12
	dragon	H	67	5	7	8	10
	helicopter	H	96	9	13	4	5

LSA	MEDIATOR	RANK	TOTAL POINTS SCORED	RANKING TALLIES 1	2	3	4
o - /ɑ/	watch	•	62	3	7	13	9
	happy face	H	100	10	8	8	6
	Dr.: "Say /a/."	H	110	18	4	4	6
	doughnut	L	58	1	13	7	11
oa - /o/	play nez surprise	L	64	7	5	7	12
	cat & mouse	•	68	6	6	10	9
	surprised faces	H	99	10	9	11	1
	float	H	79	8	11	3	9
oo - /u/	owl's eyes	H	117	19	2	8	1
	surprised eyes	H	70	6	8	8	8
	ghost's eyes	•	66	5	13	7	11
	trick cyclist	L	47		7	13	10
ow - /aʊ/	sunburned-bird	H	75	4	13	8	7
	ball hurts bird	•	73	9	4	8	11
	tire hurts tail	H	101	11	10	8	3
	a black eye	L	71	8	5	8	11
oy - /ɔ/	ball & racket	•	68	4	10	9	9
	diving board	L	63	6	9	2	14
	boy & slingshot	H	74	6	6	13	5
	pig	H	111	15	6	9	4
p - /p/	bubble popping	H	88	4	16	10	4
	popping ballon	L	75	7	8	8	11
	pistol shooting	H	112	13	3	9	9
	outboard motorboat	•	85	13	7	7	10
r - /r/	bear	H	[illegible]	[illegible]	10	11	2
	lawn mower	H	97	11	6	12	5
	coat hook	L	41	2	7	5	20
	growling lion	•	97	10	11	7	6
s - /s/	teakettle	•	85	8	9	9	11
	running hose	H	98	10	6	12	7
	seahorse	L	76	4	12	10	11
	snake	H	121	17	8	6	6
sh - /ʃ/	shake & giraffe	H	104	7	17	9	3
	"shh" signal	H	106	16	4	7	10
	snake & chair	•	83	7	10	9	11
	shark	L	77	7	6	12	12
t - /t/	cross	H	89	9	10	7	6
	clock hands	H	102	12	10	6	4
	hammer tapping	•	69	7	4	11	10
	tap dancer	L	60	4	8	3	12
th - /ð/	thin	H	89	9	6	7	11
	shocked giraffe	H	112	17	5	6	5
	hammer & chair	•	79	4	13	10	6
	thing	L	62	3	9	10	11
u - /ə/	under	•	72	5	9	10	7
	dumb smile	L	66	6	8	6	11
	yawn	H	97	12	7	8	4
	goblet	H	75	8	7	7	9
v - /v/	dentist's drill	H	82	12	4	5	7
	V for victory	H	62	6	6	7	9
	mosquito	•	80	8	8	8	4
	violet	L	54	2	10	8	8
w - /w/	wind in mountains	L	59	6	7	4	12
	whiskers	•	67	7	6	7	9
	wolf	H	75	4	11	11	3
	bat winds	H	89	12	5	7	5
y - /j/	sling shot	•	85	9	10	5	7
	wishbone	L	62	5	5	11	10
	"Yech" (disgust)	H	77	7	10	6	8
	Indian war dance	H	88	10	6	9	6
z - /z/	bee flying zigzag	H	97	15	4	5	4
	sawing wood	H	73	3	18	2	5
	lightning bolt	L	55	4	1	16	7
	sneezing swan	•	55	6	5	5	12

APPENDIX D

INSTRUCTIONS TO THE EXPERIMENTAL TEAM (ET) REGARDING THE SCHEDULE OF PROCEDURES

SCHOOL ONE

Day 1	first class	• go to first assigned class • introduce ET members • divide class into two groups according to plan (three ET members per group) • conduct pretest of eight LSAs to be presented that day	first ten minutes
		• take each group to its viewing area • present introductory film • present eight LSAs via the appropriate treatment condition films	second ten minutes
		• return children to classroom • conduct immediate posttest of LSAs presented	third ten minutes
	other classes	• go to next class and repeat the above procedure (using films appropriate to each treatment condition) until all four kindergarten classes in the school have been visited.	
Days 2 3 4		• on succeeding days in a school, activities are similar to those of the first day with three major exceptions: (1) omit presentation of introductory film; (2) a different set of eight LSAs will be taught each day; and (3) a twenty-four hour posttest of the LSAs taught on the previous day will preceed the pretest of the new LSAs.	
Day 5		• on the fifth day, the only activity conducted in each class will be the twenty-four hour posttest of the LSAs taught during the fourth day.	
One Week Later		• one week after the last twenty-four hour posttest (twelve days after the first block of eight letters is presented) return to the school and conduct a long term delayed recall posttest on all thirty-two LSAs.	
SCHOOLS TWO AND THREE		Repeat the above procedures in each of the other two schools.	

APPENDIX E

PRE- AND POSTTEST RECORD SHEET SAMPLE

CHILD'S NAME Mary Doe SEX: M (F)

AGE: YEAR: 5 MONTH: 8 ETHNICITY:* (A) B C

SCHOOL: Pillow - Group 7 TESTER: M.M.

Block One	Pre	Post 1	Post 2	Post 3	Block Three	Pre	Post 1	Post 2	Post 3
w we	x	✓	✓	x	g go	✓	✓	✓	✓
oa boat	x	✓	x	x	o Not	x	✓	✓	✓
h he	x	✓	✓	x	v vat	x	✓	✓	x
ay lay	x	x	x	x	a sat	x	✓	x	x
l lee	x	x	x	x	oy toy	x	x	x	x
e set	x	x	x	x	sh shut	x	✓	✓	✓
p pit	✓	✓	✓	✓	d dot	x	✓	x	x
t top	x	✓	✓	✓	k kin	✓	✓	✓	✓

Block Two	Pre	Post	Post	Post	Block Four	Pre	Post	Post	Post
r row	x	x	x	x	ch chip	x	✓	✓	x
b bit	x	✓	✓	✓	ow how	x	✓	✓	✓
i sit	x	x	x	x	z zoo	✓	✓	✓	✓
m me	x	✓	✓	✓	n no	x	x	x	x
ee see	x	x	x	x	j jaw	x	✓	x	x
oo boot	x	✓	✓	✓	u sup	x	x	x	x
y yet	x	✓	x	x	f fee	x	✓	✓	✓
th the	x	x	x	x	s see	✓	✓	✓	✓

*A (anglo), B (black), C (Chicano)
✓ indicates a correct response
x indicates a failure to provide the correct response

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